

Designing and Validating a Researcher's Competency Assessment Tool for Iranian Researchers

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ABSTRACT: *Competencies evaluation has been considered as a powerful management tool in defining acceptable level of performance. There is scarcity of literature on attributes and competencies of researchers. Yet, no formal or validated standard assessment tool for researchers' competencies in Iran is generated. This study was conducted in order to design a test for assessment of researchers' competencies based on Vitae Researcher Development Framework and to validate it for Iranian researchers.*

To select the sample size, Iran was divided into eights regions and questionnaires were distributed among researchers in each region. The data was collected during January to June 2014. Data collection tool included Vitae Researcher Development Framework. The validity of translated questionnaire was assessed by using the opinion of 24 experts. The reliability of questionnaire was measured by using Cronbach's α and Guttman's Lambda 2. Also, composite reliability test and classification reliability tests were performed to measure the reliability of questionnaire and its sub scales. Confirmatory factor analysis (CFA) and Exploratory Factor Analysis (EFA) were applied to investigate validity and reliability by the use of AMOS software.

The results of CFA showed that to validate this tool for Iranian researchers 14 descriptors and two domains should be deleted from the questionnaire. Also, the result of CFA showed that questionnaire should be divided into two questionnaires, which one of them measures the professional competencies of researchers and the other measures the general competencies related to personal effectiveness, research organization and governance, and communication, influence and impact. Considering these changes, the model was fitted for the two questionnaires. The level of reliability was at a desired level for both questionnaires. The mean score of Iranian researchers on the domains and sub-domains of the questionnaire showed that the overall scores were very poor and less than 50% of the total score.

Keywords: Researcher, Competency, Assessment Tool, Evaluation

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1. Introduction

Competencies evaluation has been considered as a powerful management tool in organizations and in defining acceptable level of performance (Anne Lee, 2009). Movement in human resource management sciences towards competencies has resulted in generation of extensive knowledge on competency and competencies assessment in different fields (Boyatzis, 1982; Boyatzis, 2008), however; yet there is scarcity of literature on attributes and competencies of researchers (Anne Lee, 2009).

Spencer defines competencies as 'motives, traits, self-concepts, attitudes or values, content knowledge, or cognitive or behavioral skills – any individual characteristic that can be measured or counted reliably and that can be shown to differentiate significantly between superior and average performers, or between effective and ineffective performers. Competencies include an intention, action and outcome.' (Spencer, McClelland, & Spencer, 1990) Competencies are the measurable or observable knowledge, skills, abilities, and behaviors (KSABs) critical to successful job performance (Wuim-Pam, 2014). It is suggested that developing competencies framework for researcher should accommodate disciplinary differences and allow mobility from academic and outside academic career. In order to develop competencies required by researchers, recognizing the nature of research is necessary. Research is defined as 'original investigation undertaken in order to gain knowledge and understanding' (Research Assessment Exercise, 2008). However this definition leads us to a very limited view of the role of researchers (Anne Lee, 2009). The main skills required for researchers are suggested as disciplinary or interdisciplinary-based critical thinking (Donald, 2002). The term 'critical thinking' is described by the intellectual, philosophical and analytical approaches to understand, critique and create the argument and is used for problem solving (Anne Lee, 2009).

Researchers are required to perform different roles and tasks as creators and custodians of knowledge, as team members, as teachers, as supervisors, as academic practitioners, as fund-raisers and as communicators (Rowley & McCulloch, 1999). In addition, as research become an international business, cultural competences are required for researchers to become internationally recognized (Anne Lee, 2009). Therefore, competencies assessment should include all these different aspects.

Research ground the basis for planning, policy making, legislation and direct future movement of human development and henceforth, evaluation of competencies for those who are promoting research is a critical issue. Also, research production can be a result of development and scientific growth. Therefore, researchers' competencies can play an important role in development; and assessment of the level of researchers' competencies is necessary for planning for education, training and using the avail resources in this field in each country.

In order to design a researchers' competency assessment tool for Iranian researchers, many different models was reviewed (Glasgow Caledonian University, 2009; Willison & O'Regan, 2006; Research Councils and Arts and Humanities Research Board, 2002; Government social research [GSR], 2009; Faculty of General Dental Practice (UK), 2007; York, 2005; University of Surrey, 2005), that among them, Vitae model of Researcher's Development Framework was selected. Vitae is a not-for-profit registered UK charity supported by Research Councils UK (RCUK), managed by the Career Development Organization (CDO). It is a champion in the personal, professional and career development of researchers and is globally known as leading organization in expertise at enhancing the skills and career impact of researchers in UK and around the world (Weightman, 1994). Vitae has developed the Vitae Researcher Development Framework through several sets of interview and focus group discussions (Reeves, Denicolo, Metcalfe & Roberts, 1994).

The purpose of developing this framework was to help researchers to develop their competencies. This model is one of the most comprehensive models in competencies assessment of researchers, which is based on self-assessment. Weightman proposed variety of method for competencies assessment including self-assessment, systematic structured observation, repertory grid, interviews and consultation (Weightman, 1994).

The contribution of Iranian researchers to generation of knowledge at the international level is poor against considerable expansion in the number of universities, faculty members and graduate students in different levels of science in the recent decades (Malekzadeh, Mokri & Azarmina, 2001). The level of researchers' competencies could be one of the contributing factors to the existing situation.

Malekzadeh et al. study on medical science and research in Iran showed a mismatch between Iran's current potentials and the scientific contribution of Iranian researchers in medical fields. Their study concluded that well-designed interventions are required for present retardation to be overcome (2001). These interventions could include evaluation and enhancing Iranian

researchers' competencies.

Yet, there is no formal or validated standard assessment tool for researchers' competencies in Iran. This study was conducted in order to design a test for assessment of researchers' competencies based on Vitae Researcher Development Framework and to validate it for Iranian researchers.

2. Methodology

The study sample size was determined as 382 based on Cochran formula (type I error ($\alpha=0.05$) and type II error $\beta=0.2$) (Cochran, 1963).

To select the sample size, Iran was divided into eight regions of north, north-east, north-west, west, east, south, south-east, south-west and central. In each region, one focal point was selected to conduct the study and fill the questionnaire via interview. 45 questionnaires were sent to each focal point to give to the identified researchers in the country. Researchers were selected from the list of research centers and organizations located in the region from different fields of sciences and of governmental and private research centers and organizations. The data was collected during January to June 2014.

Data collection tool included Vitae Researcher Development Framework, which is based on self-assessment and a data collection forms that collected general and demographic information of the researchers.

Vitae Researcher Development Framework consisted of four domains, 12 sub-domains and 63 descriptors. The four domains encompass knowledge and intellectual abilities (Domain A), personal effectiveness (domain B), research governance and organization (domain C) and engagement, influence and impact (domain D), which includes not only the knowledge, intellectual abilities, techniques and professional standards to do research, but also the personal qualities and skills to work with others and ensure the wider impact of research. There are three sub-domain of A1 - knowledge base (7 descriptors), A2 - cognitive abilities (5 descriptors) and A3 - creativity (5 descriptors) for domain A. B1 - personal qualities (6 descriptors), B2 - self-management (5 descriptors) and B3 - professional and career development (5 descriptors) are the three sub-domains of domain B. The three sub scale of domain C includes C1 - professional conduct (7 descriptors), C2 - research management (3 descriptors), C3 - finance, funding and resources (3 descriptors); and finally the three sub scales of domain D includes D1 - working with others (8 descriptors), D2 - communication and dissemination (3 descriptors) and D3 - engagement and impact (6 descriptors) (Figure 1). Each of the 63 descriptors contains between three to five phases, representing distinct stages of development across the whole research career.

The respondents did not know these categories while responding to the questionnaire. Vitae Researcher Development Framework was double translated from English to Persian and from Persian to English using a professional translator in this field.

The face and content validity of translated questionnaire was assessed by using the opinion of 24 experts in the field of research methodology, statistics and management. The construct validity was assessed using confirmatory factor analysis (CFA) AMOS software. Face Validity, Content Validity, Structural Validity, Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI) and Normed Fit Index (NFI), Relative Fit Index (RFI), Comparative Fit Index (CFI), Incremental Fit Index (IFI), Root Mean Square Error Of Approximation (RMSEA) were used for assessing the validity of questionnaire.

The reliability of questionnaire was measured in two stages. In first stage, when 100 questionnaires were filled by the researchers, Cronbach's and "if deleted" option was used to remove those items that reduced the reliability, significantly. As the result, five questions were deleted and the final questionnaire contained 58 questions. In the second phase, at the end of data collection (303 questionnaires), reliability was measured using Cronbach's α and Guttman's Lambda. Also, composite reliability test and stratified reliability tests were performed to measure the reliability of questionnaire and its sub scales.

3. Statistical analysis

Descriptive statistics was used to analyze the data using SPSS software version 19. Confirmatory factor analysis (CFA) and Exploratory Factor Analysis (EFA) were applied to measure construct validity and reliability by the use of AMOS software.

4. Results

Table 1 shows the characteristics of researchers participated in the study. Mean age of participants was 30.6 years (range 24-60 years). Mean work experience in research position was 4.77 years ((range 1 - 24 years).

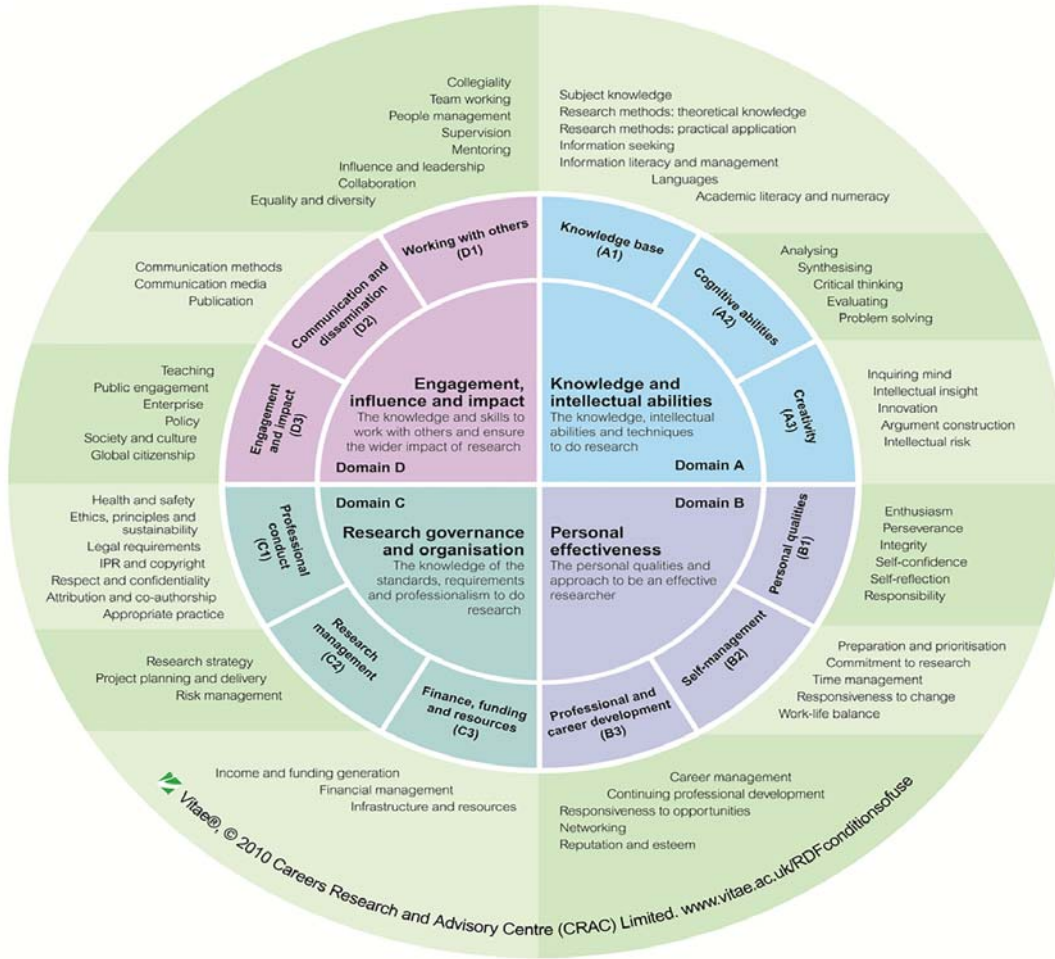


Figure 1. Domains and sub-domains of Vitae Researcher Development Framework Source: Vitae Careers Research and Advisory Center

Validity Assessment

To assess the validity of the tool designed based on Vitae Researcher development Framework, CFA was used. Each domain of the questionnaire was entered in the Amos software separately to assess the association between each viable and other variable in that domain. When all 15 questions related to scale A (knowledge and intellectual abilities) were entered in the software, the variable A 1.2 (Research methods - theoretical knowledge) and A 1.7 (academic literacy and numeracy) had a negative association with other variables and therefore were removed from the questionnaire and therefore 13 questions were remained in this domain. CFA of this 13 items questionnaire of domain A showed a positive significant association with each other and with this domain. The GFI and RMSEA for the domain A confirmed the fitness of this 13 items questionnaire for domain A (Table 2).

The CFA on B scale (personal effectiveness) with three sub scales and 14 questions (variables), showed that the sub scale B3 (professional and career development) with 4 questions had a negative association with other sub scales of this domain and therefore was deleted from the questionnaire. Again, The CFA was performed for domain B with 10 items which showed a positive significant association among all variables and the level of GFI and RMSEA confirmed fitness of this model for domain B (Table 2).

Characteristics	Number (303)	Percentage	Characteristics	Number (303)	Percentage
Gender			Educational background		
Male	111	63.4	Basic science	16	5.3
Female	192	36.6	Engineering	10	3.3
Marital status			Humanities	219	72.3
Married	136	44.9	Medical/medical sciences	58	19.1
Single	166	54.8	Organization		
Others	1	0.3	Governmental	250	82.5
Educational level			Private	51	16.8
Master	255	84.2	No response	2	0.7
PhD	47	15.5			
Post doc	1	0.3			

Table 1. Characteristics of the participants

The CFA on C scale (research organization and governance) with three sub scales and 12 questions (variables), showed that sub scale C2 (research management) with three variables had a negative association with other sub scales of this domain and therefore was deleted from the questionnaire. Also, the variables C1.6 (attribution and co-authorship) and C1.7 (appropriate practice) had a negative or no association, respectively, with other variables and therefore were deleted from the questionnaire. The CFA was performed for the 7 remaining variables of domain C which showed that C1.1 (health and safety) and C 1.3 (legal requirements) had a negative or no association with other variables, respectively, and therefore were deleted from the questionnaire. For the third time, CFA was performed for the remaining 5 variables of domain C which showed a positive significant association among all variables and the level of GFI and RMSEA confirmed fitness of this model for domain C (Table 2).

CFA was performed on the three sub scales of domain D with 17 variables which showed that the variable D1.6 (influence and leadership) has a negative and not significant association with other variables and therefore was deleted from the questionnaire. CFA was performed on the remaining 16 variables which showed a positive significant association among all variables and the level of GFI and RMSEA confirmed fitness of this model for domain D (Table 2).

In the next stage, CFA was performed for the total four scales of the questionnaire, and it was shown that there was no association between scale A and other scales and therefore this scale were separated from this questionnaire, which resulted in forming two questionnaires. The CFA was performed for A questionnaire and C+B+D questionnaire, separately which showed a positive significant association between A scale and its three sub-scales and a positive significant association between B and C and D scales and their sub-scales. Therefore two tests were generated. First test assesses the professional competencies of researchers and was called 'Researchers Professional Abilities Assessment Test' (RPAAT) the second test assesses the general competencies of researchers and was called 'Researchers General Abilities Assessment T' (RGAAT).

The validity assessment measures for RPAAT and RGAAT showed the fitness of these models for these two questionnaires (Table 2).

Figure 2 and 3 show the fitness of these models for RPAAT and RGAAT, respectively.

Table 3 shows the scales sub-scales and descriptors of the two standard questionnaires (RPAAT and RGAAT) for Iranian researchers.

Model (default model)	GFI	AGFI	NFI	RFI	CFI	IFI	RMSEA
Domain A (13 variables)	0.988	0.936	0.982	0.916	0.994	0.995	0.037
Domain B (10 variables)	0.971	0.971	0.952	0.957	0.966	0.967	0.086
Domain C (5 variables)	1.000	-	1.000	-	1.000	1.000	-
Domain D (16 variables)	0.930	0.884	0.936	0.944	0.943	0.945	0.038
RPAAT (13 variables)	1.000	-	1.000	-	1.000	1.000	-
RGAAT (31 variables)	0.989	0.938	0.991	0.964	0.995	0.938	0.065

Table 2. Model fitness for the four domains and the two questionnaires

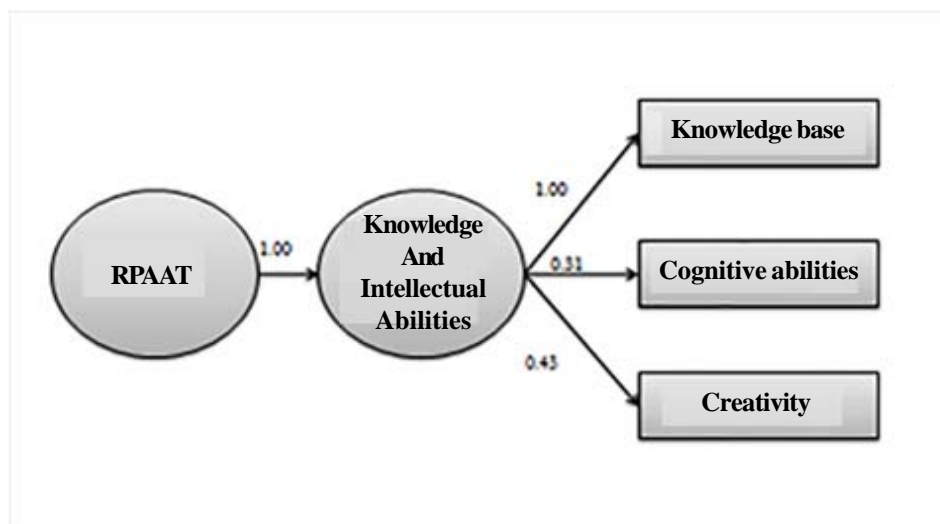


Figure 2. Fitness model of RPAAT

Reliability assessment

In the first phase of measuring reliability of the questionnaire with 100 questionnaires, pilot study, Cronbach's α with 'if deleted' option was used and the result showed that removing questions related to evaluation skill from sub scale A2, intellectual risk from sub scale A3, work-life balance from sub scale B2, networking from sub scale B3 and infrastructure and resources from sub scale C3 increases the reliability and therefore these questions were deleted from the questionnaires and the study questionnaire contained 58 questions. The second phase of reliability assessment was performed at the end of study on validated questionnaires (44 questions in two questionnaires). Table 4 shows the result of second phase of reliability assessment (303 questionnaires). Reliability of all sub scales and domains of questionnaires were at a desirable or acceptable level except for sub-domain A2.

Scoring of the two questionnaires of Researchers Ability Assessment Test (RAAT)

Table 5 shows the mean, maximum and minimum scores of each domains and sub scales and the scores that participants obtained in each domain and sub scale based on RAAT. Table 5 shows that Iranian researchers obtained a maximum 40.8 percent of the total score in domain B (personal effectiveness) and minimum 28.1% in domain C (research organization and governance). Among sub scales the highest percentage belonged to D1 (collegiality) (40.4%) followed by A1 (subject knowledge) (40.2%). The lowest percentage of the total score was 28.0% belonged to C2 (IPR and copyright ethics), followed by 28.2% belonged to C1 (principles and sustainability).

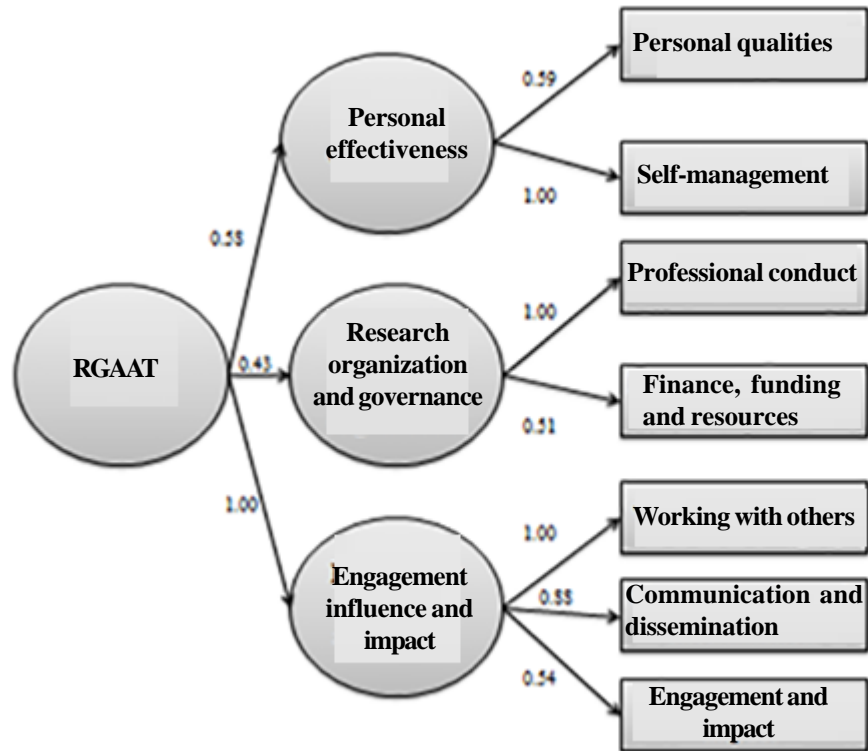


Figure 3. Fitness model of questionnaire RGAAT

Table 6 shows the categorization of researchers' competencies test based on the cutoff points in scores of researchers in Iran. Four categories were defined as Leader Researcher, Established Researcher, Recognized Researcher, and Starter- New Researcher.

5. Discussion

Research and development activities are the major contributors to socio-economic development of many countries. Along with many other factors, competency of researchers has its share on enhancement of research and development in each country. Considering scarcity of tools on researchers' competencies assessment and lack of standard and formal method of researchers' competency assessment in Iran, this study was conducted to design and validate an ability assessment test based on Vitae Researcher Development Framework for Iranian researchers. Three hundred and three randomly selected researchers from different research centers and organizations across Iran filled a 58 items test that assessed their research competencies in four broad domains of knowledge and intellectual abilities, personal effectiveness, research organization and governance and communication, influence and impact during January to June 2014.

In this study CFA was used to assess the construct validity of questionnaire. Messick clarifies that construct validity is the 'integrating force that unifies validity issues into a unitary concept' (Messick, 1990). The results of CFA showed that to validate this tool for Iranian researchers 14 descriptors and two domains should be deleted from the questionnaire. As validity shows the degree to which empirical evidence support the adequacy and appropriateness of theoretical rationales (Messick, 1990), therefore, sometimes removing some items which are inappropriate to the empirical evidence is inevitable. Also, the result of CFA showed that questionnaire should be divided into two questionnaires, which one of them measures the professional competencies of researchers and the other measures the general competencies related to personal effectiveness, research organization and governance, and communication, influence and impact. Considering these changes, the model was fitted for the two questionnaires. The level of reliability was at a desired level for both questionnaires.

This finding showed that when the framework developed by Vitae through qualitative method was tested through quantitative method to make an assessment tool, the structure and context had to be modified. It means that in addition to eliminating

Questionnaire	Sub-scale	Descriptor
RPAAT		
knowledge and intellectual abilities	Knowledge base	Subject knowledge
		Research methods - practical application
		Information seeking
		Information literacy and management
	Cognitive abilities	Languages
		Analyzing
		Synthesizing
		Critical thinking
	Creativity	Problem solving
		Inquiring mind
		Intellectual insight
		Innovation
ARGUMENT CONSTRUCTION		
RGAAT		
Personal effectiveness	Personal qualities	Enthusiasm
		Perseverance
		Integrity
		Self-confidence
		Self-reflection
	Responsibility	
	Self-management	Preparation and prioritization
		Commitment to research
Time management		
Research organization and governance	Professional conduct	Responsiveness to change
		Ethics, principles and sustainability
		IPR and copyright
	Finance, funding and resources	Respect and confidentiality
		Income and funding generation
		Financial management
Communication, influence and impact	Working with others	Collegiality
		Team working
		People management
		Supervision
		Mentoring
		Collaboration
	Communication and dissemination	Equality and diversity
		Communication methods
	Engagement and impact	Communication media
		Publication
TEACHING		
RPAAT		
RGAAT		
Public engagement		Public engagement
		Enterprise
		Policy
		Society and culture
		Global citizenship

Table 3. The scales sub-scales and descriptors of two validated questionnaires for Iranian researchers

some items, the whole framework was divided into two tools, which one assessed the professional skills of researchers and the second assesses the general and behavioral skills. Therefore, although it is ideal that professional skills be aligned with the general and behavioral skills, but in reality and among Iranian researchers, these two were not aligned and could not be assessed in one test.

In addition, it worthy to mention that professional skills can be referred as researchers' competencies but general and behavioral skills can be referred as competence of a researcher. Rowe clarified 'competence' mean a skill and the standard of performance reached while 'competency' refers to the behavior by which it is achieved. (Rowe, 1995) This study also identified two

Scales	Cronbach's α	Guttman's Lambda	Stratified alpha reliability
A1	0.657	0.666	-
A2	0.458	0.495	-
A3	0.705	0.718	-
B1	0.781	0.794	-
B2	0.689	0.699	-
C1	0.625	0.635	-
C2	0.650	0.650	-
D1	0.798	0.815	-
D2	0.795	0.796	-
D3	0.670	0.715	-
A	0.784	0.801	0.803
B	0.821	0.832	0.834
C	0.722	0.741	0.747
D	0.888	0.900	0.892
Total questionnaire with 4 scales	0.882	0.897	0.868
Total questionnaire with 3 scales	0.911	0.922	0.889

Table 4. The result of reliability assessment of the validated questionnaire with 303 samples

independent assessment tests for assessing researchers' professional skills and researchers' general and behavioral skills.

The mean score of Iranian researchers on the domains and sub-domains of the questionnaire showed that the overall scores were very poor and less than 50% of the total score, which showed that policy makers and planners should consider improvement of competencies of Iranian researchers. Among different domains, domain C (research organization and governance) had the lowest score. Domain C reflects the knowledge of the standards, requirements and professional conduct that are needed for an effective management of research. The low score in this domain can adversely affect the optimal progress of researchers in Iran and reduce cost effectiveness of research budgets in Iran, which is already constraint. However, the personal effectiveness domain which contains the personal qualities, career and self-management skills required for taking ownership for and control of professional development was higher compared to the score of other domains among Iranian researchers.

This study identified four categories to rank researchers based on competencies level as starter- new researchers, recognized researchers, established researchers, and leader researchers. Rowley and McCullochin offering a model for researchers development, have explained the path that a researcher join the researchers community through stages from 'apprentice' to 'member' [of community of practice] to 'expert' to 'leader' (Rowley & McCulloch, 1999). Also, European Researchers Career Development has classified researchers, similar to this study as starter- new researchers, recognized researchers, established researchers, and leader researchers (Chartered Institute of Personnel and Development, 2009).

6. Conclusion

In conclusion, this study resulted in generation of two validated tests for assessment of researchers' competencies in Iran.

Domain/sub scale	Standard questionnaire scores		Participants Scores		
	Minimum	Maximum	mean (SD)	Percentage of total score	minimum-maximum
RPAAT					
Domain A	1	4.42	1.60 (0.40)	36.2	1 - 3.66
A1	1	4.380	1.76 (0.56)	40.2	1 - 4
A2	1	4.375	1.42 (0.39)	32.5	1 - 3.5
A3	1	4.625	1.61 (0.58)	34.8	1 - 3.88
RGAAT					
Domain B	1.33	4.680	1.91 (0.50)	40.8	1.08 - 3.75
B1	1.166	4.750	2.16 (0.60)	45.5	1.17 - 3.67
B2	1	4.625	1.67 (0.54)	36.1	1 - 4
Domain C	1	4.875	1.37 (0.50)	28.1	1 - 3.42
C1	1	5	1.41 (0.56)	28.2	1 - 3.83
C2	1	4.750	1.33 (0.61)	28.0	1 - 3.25
Domain D	1	4.613	1.64 (0.48)	35.6	1 - 3.37
D1	1	4.428	1.79 (0.55)	40.4	1 - 3.57
D2	1	4.830	1.67 (0.62)	34.6	1 - 4.17
D3	1	4.583	1.46 (0.45)	31.9	1 - 2.75

Table 5. The maximum and minimum scores of each domains and sub scales and the mean scores that participants obtained in each domain and sub scale

Score	1 to 1.99	2 to 2.99	3 to 3.99	≥ 4
Level	Starter- New Researcher	Recognized Researcher	Established Researcher	Leader Researcher

Table 6. Categorization of researchers' competencies

Based on the Iranian researchers' cutoff scores on the assessment tool, four different broad categories were defined for categorizing the researchers' competencies. In addition, this research showed a low level of competencies among Iranian researchers and the need for a proper planning for developing skills and knowledge of Iranian researchers to increase their competencies.

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