FACTOR STRUCTURE OF SUCCESSFUL INTELLIGENCE TEST AMONG PREPARATORY SCHOOL STUDENTS

Prof. Dr. NABEEL ABDULGHFOOR A.ALMAJEED

University of Mustansiriya / College of Education

ABSTRACT

Intelligence tests are often used by researchers in Iraq to measure intelligence of preparatory school students for research or diagnostic purposes. Apparently, they differ in selecting intelligence test used in these studies in terms of the theoretical frameworks behind the tests. In the current research, the researcher adopted Sternberg's Triarchic intelligence test which emphasizes in its theoretical framework the three abilities (analytical, practical, and creative), and most of the tests adopted have ignored their factor structure. In the light of the enormous technological progress and the spread of the advanced statistical programs, special programmes have been designed for the use of confirmatory factor analysis by which we can reach the fitness between the factor structure of the test based on a theoretical framework and the data obtained by the researcher to reach the factor structure of the test, and this will be addressed by the current research.

Key words: factor structure, triarchic, intelligence, preparatory

RESEARCH PROBLEM

Intelligence tests are often used by researchers in Iraq to measure intelligence of preparatory school students for research or diagnostic purposes. Apparently, they differ in selecting intelligence test used in these studies in terms of the theoretical frameworks behind the tests. The researcher has not found in these studies an experimental or practical justification to select a test among other tests which become common in Iraq whether they are foreign standardized tests or not standardized on Iraqi environment, or other Arabic tests prepared for or standardized on another Arab countries, or tests that prepared by Iraqi researchers on Iraqi samples of various social stages and sectors. The researcher noted that the selection of a test by a researcher was not based on scientific bases.Rather it is based on researcher's selection and his own desire, but lacks criteria or precisepsychometric properties that may affect the measurement of what has been prepared for measurement, which is intelligence measurement. In view of the aforementioned, the research problem is concentrated in the following question: what is the factor structure of successful intelligence test among preparatory school students?

RESEARCH IMPORTANCE

human intelligence is a controversial question. Controversy has raged amongpsychologists to reach an agreed specific definition of this concept. The difficulty of agreeingon specific definition lies in the difference in the theoretical trends in the abstract nature of intelligence.Therefore, psychometric has encountered many difficulties and obstacles in measuring human phenomena because they are intangible hypothetical constructs that are difficult to define clearly and accurately. Therefore, their measurement is not direct, but through the reflective behaviours that are indicative of them, as well as measurement is not for the whole phenomenon, but for a sample of it (Aiken,1988, P.15-16). Successful Intelligence Theory is the input to cognitive processes of intelligence understanding, where intelligence includes the skills and knowledge required for success in life, as defined by the individual within the

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social context. "Sternberg"points out that every task in life will require one or more special abilities of intelligence (analytical, practical and creative). The analytical intelligence allows the individual to carefully examine and select the skill that would solve problem.Creative intelligence is emerged by individual's ability to think independently based on his previous knowledge to complement the target task. Practical intelligence is emerged by individual's ability to benefit from his previous or required knowledge and employs it to achieve success in his environment and daily life. Intelligence makes the individual able to invest in the abilities involved (analytical, practical and creative). It enables the individual to analyze the problem, find a solution and apply this solution. That is, an individual with intelligence is able to develop the skills required for success as he defines them from his personal point of view, and can reach success and achieve his goals through analytical, creative and practical abilities, and he would be distinguished in relation to one of these abilities or in the way in which he balances these abilities to achieve distinction (Sternberg &Grigorenko, 2007: 276).

The importance of the current research could be highlighted by providing teachers and graduate students researchers (Master's and Ph.D.) with a psychometric test, including knowledge of the factor structure of the successful intelligence test which is based on a theoretical background of the three abilities (analytical, practical and creative) depending on the confirmatory factor analysis which is the construct validity of the test.

RESEARCH OBJECTIVE

the current research aims to identify the factor structure of the successful intelligence test of preparatory school students.

RESEARCH SAMPLE

to achieve the research objective, identification of factor structure of Sternberg's successful intelligence test, a sample of (400) male and female students was selected in stratified random method, by (6)preparatory schools in Baghdad, three of which are of Directorate of Educational Karkh First and three of which are of Directorate of Educational Rusafa First, as shown in table (1).

Table (1) the research sample: preparatory school students by gender, specialization and directorate

Directorate	District	School	Gender	Scientific Male	Scientific Female	Literary Male	Literary Female	TOTAL
RusafaFirst	Hay Tunis	Alfrahidi For Boys		20		14		34

District	Sub-district	School					
	Al-Qahirah	Um Albaneen For Girls		12		13	25
		Alrisalah For Boys	12		20		32
		Alfouz For Girls	18			20	38
	Hay Ash-Shammasiyah	Al Intisar For Girls	16		16		32
		Ash-Shammasiyah For Boys		12		17	29
TOTAL			48	42	50	50	190
Karkh First	Al-Mansour	Al-Raid for boys	16		18		34
		Al-Kifah Al-Arabi for girls		16		16	32
Al-	Al-Jamiaa	Al-Jamiaa for girls	18		20		38
		Al-Quds for boys		20		18	38
		Al-Maamoun for boys	18		20		38

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			10		20	30
	Al-Yarmouk for girls					
	TOTAL	52	46	58	54	210
	GRAND TOTAL	100	88	108	104	

THE THEORETICAL FRAMEWORK

(Theory of Successful Intelligence): Sternberg's theory of successful intelligence is one of modern theories that attempt to explain the nature of human intelligence. Sternberg's interest has become not only in the cognitive processes, but also in relationship between these processes and the intelligence behavior in real life (Al-Azawi, 2004:44). This theory has received support by many of cognitive psychologists; therefore, it is of special of special importance in this field. Sternberg continued working on his theory by modifying, developing and researching and come up with new vision for it called "theory of successful intelligence". This theory is largely used by educationalists and psychologists researchers because it is the center of attention in educational community during the last three decades of the past century until present day. It also provides the researcher with theoretical and practical framework for the theories with which he deals for giving them a sense of meaning such as Information Processing Theory and other intelligence theories that deal with intellectual elements and processes that affect intelligence, which work within a wide space,socialculture space (Sternberg, 1996:320). Sternberg believes that there are three components or abilities related to successful intelligence:

First: Analytical Creative: an individual with analytical intelligenceisparticularly able to analyze, judge, criticize, compare, differentiate, evaluate, clarify, and perform distinctly in schoolon standardized test and intelligence tests that significantly measure the analytical abilities as

well as the abilities of remembering, assessing of existing options in life and identifying differences. Analytical intelligence plays a key role in educational attainment and academic achievement, it generally involves the ability to solve problems and evaluate different ideas and positions (Sternberg &Grigorenko, 2007: 270). The study of this kind of abilities according to Sternberg's Theory of Successful Intelligence depends on the knowledge and understanding of cognitive processes involved in this behaviour, which are identified in three components of information processing (organizational, performance and knowledge acquisition components)(Janet & Samuel, 2001:349).

Analytical intelligence tests provide cognitive problems that have one solution.For example, questions that can be raised through words and their inversions or how to solve arithmetic progression and its problems by finding the missing number. For example, what is the relationship between the series of numbers (17, 12,8,5,30)? People with analytical intelligence can come up with a solution to such a question, as well as questions of general mathematical information and some similar tests that mainly depend on what an individual has learned at school or through books, that is why Sternberg in 1985 pointed out that analytical intelligence can be observed and pursued through individuals with academic intelligence. Analytical thinking is a systematic, successive and sequential thinking with firm steps in their development. Individual thinking moves via specific stages by criteria that determine his success by identifying a problem facing the individual that leads him to undertake necessary activities for solution, to

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observe, to collect necessary information about the problem in order to understand and analyze it, to develop hypothesis after collecting information, to analyze problem, to work on proving these hypotheses with other information and individual's previous experience and finally to reach the definitive results and general laws and rules (Sternberg &Grigorenko, 2007: 153).

Second: Creative Intelligence:an individual with creative intelligence is particularly able to create, invent, discover, imagine, and make assumptions. It is worth noting thatthe conventional tests of intelligence do not measure creativity, as is the case with the test of "Stanford-Binet" and of "Wechsler"(Sternberg&Grigorenko, 2007: 272). Creative intelligence emerges when you use your imagination in writing short story, in making a painting within an artistic framework or in a certain advertising work, and as opposed to the analytical intelligence which requires innovative solutions that have multiple and possible answers, that is, they have open ends.Creativity as an attribute can be measured by special tests such as the "Torrance" test, which is one of the most important tests of creativity. It measures components such as fluency, flexibility, originality and elaboration. Sternberg urges that creativity is the ability to generate novel and unique ideas that proper to required task (Sternberg, 1994: 189). Therefore, creative intelligence involves two fundamental abilities: the ability to deal with novelty, which includes individual's ability to use his previous information and the proper organization of his performance components to deal with novel situations or problemsin a consensual manner. And the ability to convert new skills learned in situations that have not been encountered before to automatized skills that do not take many sources of memory and attention. Consequently, people who are more able to convert new skills to automatized skills are more able to acquire more information faster than slower people in making this conversion, and these abilities need resources such as cognitive processes (comparison, redefining problems, choosing formulation, integration, knowledge, patterns of thinking, personality, stimulation and environment).There are phrases that describe this kind of abilities such as learning from mistakes or learning from experience (Sternberg, 1997: 69).

Third: Practical Intelligence:is the ability to formulate new ideas, to combine unrelated ideas and to cope up with unfamiliar tasks in a spontaneous manner. An individual with practical intelligence is particularly capable of applying, employing, putting things into practice and benefiting from them, andshowing intelligence in daily life circumstances. This knowledge can be found in him, observed or not observed, and this individual has the necessary knowledge for success in daily life, and that knowledge is not necessary learned or verbal (Sternberg, 1997:14).

Sternberg defines practical intelligence as "the ability to create an ideal fit between individuals and their environment by adapting to or changing the environment, or by choosing a new environment in which the individualcan meet his goals". Practical intelligence here is a type of intelligence related to success in daily life associated with common sense or practical intelligence (Street Smart)versus academic intelligence or it is opposed to academic intelligence or book smart (Sternberg, 1997:100).

Therefore, in the light of the theoretical framework thatSternberg highlights that intelligence tests when used or adopted, we must consider the environment and cultural perspective of the society in which the individual lives.However, all researchers who adopted the successful intelligence test whether in the Iraqi environment or in the Arab environments did not heed the nature of their societies. They adopted Sternberg's test as it is without resorting to knowledge of its confirmatory factor structureand the extent to which it is fit the test for its theoretical background and the nature of their societies. According to this, in the current research, the researcher will adopt Sternberg's successful intelligence test and its framework with the extent of its fit for the Iraqi environment by extracting confirmatory factor structure of the test.

Factor structure: factor analysis is a statistical method for interpretation of positive correlation coefficients that have statistical significance among the various variables, i.e. it is a mathematical process for simplifying correlations among the various variables included in the analysis,leading to common factors that describe the relationship among these variables and their interpretation (Cattel,1952, P.15). The factor, therefore,

is a latent variable but is differ from the variables in that most variables can be measured directly, whereas the factor is a hypothetical variable derived from analysis of data of set of variables that have been measured directly (Fabrigar,et,al,1999, P.18). Factor analysis usually begins with calculating the correlations among a number of variables, through which we obtain a matrix of correlations among these variables in a sample, and then we analyze this correlation matrix by factor analysis to reach the minimum number of factors that enable us to express the greatest variance among these variables. Factor analysis aims to construct and test hypotheses and identify the least number of factors that can explain the relationships we observe among a large number of variables. That is, the function of factor analysis is to reduce the number of variables observed for easy interpretation. Eyzank explained that analysis factor has three fundamental objectives: description, proving hypotheses and suggesting hypotheses from initial data (Eyzank, 1953, P.20-22).

There are two types of factor analysis: exploratory factor analysis and confirmatory factor analysis. In exploratory factor analysis, the researcher does not assume a certain factor structure, but will discover it after the completion of the factor analysis, therefore called exploratory factor analysis.There are several numbers of methods in SPSS package to extract and explore factors such as Principal Axis Factoring, Maximum Likelihood, Unweighted Least Squares, Generalized Least Squares, Alpha Factoring, and Image Factoring. Fabriger, in his evaluative study of the practice of using exploratory analysis, considers that when the distribution of the scores of measured variables is normal or close tonormality, the Maximum Likelihood method is preferred without the other methods of analysis, and if date distribution is significantly not normal, Principal Axis Factoring method is preferred (Fabrigar,et,al,1999, P.48).Thus, the maximum likelihood method and principal axis factoring lead to the best results, so that the first one is used if the data is normal or close to normality, and the latter is used if the date is not normal (Ostello& Osborne, 2005,P.56).

As for confirmatory factor analysis, the researcher assumes, before using it, a conceptual theoretical model that illustrate this factor structure of a certain concept or subject. That is, the research, prior to conducting the factor analysis, assumes in advance the number of factors that form a particular concept, and assumes whetherthese factors are related to each other, including the nature of their correlation, or independent unrelated factors. The researcher shows the indexes or measured variables that saturate each factor without any other factors, and the researcher,prior to conducting the factor analysis, also illustrate measurement errors for each measured variable, and may assumes the correlation the measurement errors of measured variables belonging to a particular factor or to other factors. Therefore, if the researcher begins from clear theoretical framework of a model structure or a theory and ascertains the extent to which the theory or the model is fit to date, the method is called confirmatory factor analysis. Accordingly, the model is called confirmatory factor model.Two types of confirmatory factor analysis can be distinguished: normal Confirmatory Factor Analysis, called Non-hierarchical Confirmatory Factor Analysis or Confirmatory Factor Analysis of the First Order, and the second is Hierarchical Confirmatory Factor Analysis orConfirmatory Factor Analysis of the Second Order (Ostello& Osborne, 2005, P.56).

As for the current research, the researcher adopted Sternberg's theory and definition of successful intelligence test (analytical, practical and creative). Therefore, these three abilities are independent factorsand a number of items are relatedto each ability.The researcher will therefore rely on the first type in identifying the factor structure of the intelligence test,the model of confirmatory factor analysis, which is calledNon-hierarchical Confirmatory Factor Analysis or Confirmatory Factor Analysis of the First Order. The researcher will work to confirm the theory he has adopted with the date he will get to reach the factor structure of Sternberg's successful intelligence test.

RESEARCH METHODOLOGY AND PROCEDURE:

Research Tool: The researcher adopted Sternbergtest of successful intelligenceprepared for preparatory school students. The test consists of set of sub-tests measuring the analytical, practical and creative abilities through nine sub-tests of multiple-choice typewhich used bySternberg in his empirical studies. The test does not measure the traditional abilities, as it measures the

analytical, practical and creative abilities (Sternberg, 1998:105). These tests are applied to the 16 – 18 age group. The nine sub-tests should preferably be given in one session,and the test can be applied individually or collectively, each sub-test consists of four questions.The application of each sub-test of the nine tests took 5 minutes, with the possibility of increasing the time for some students if necessary, that is, the application of the nine objective tests takes 45 minutes or more if needed (according to Sternberg's experiments), and it has applied to preparatory school students in Iraqi schools. To achieve the research objectives, the researcher adopted Sternberg's test of successful intelligence applied to the Iraqi environment. The test is composed of 36 multiple choice questions and are distributed into 9 subscales each 3 of which measure a type of ability (analytical, practical and creative), as subscales (1, 2 and 3) measure analytical ability, and subscales (4, 5 and 6) measure practical ability, andsubscales (7, 8 and 9) measure creative ability, by 4 questions for each subscales, and each question consists of a sentence or graphics followed by 4 possible responses, from which the correct response could be selected by the respondent. Illustrations were shown before reviewing the questions and graphics in each subscale.

PSYCHOMETRIC PROPERTIES OF TRIARCHIC ABILITIES TEST:

Test Validity:

Construct Validity: is one of the most representative types of validity concept. It is the extent of measurement scale for a hypothetical composition or certain psychological concept. The researcher adopted some hypothesis to build the test such as the ability of its items to distinguish and their homogeneity through associating them with the total score of the dimension to which they belong. All items of the successful intelligence test have the ability to distinguish between respondents, and are homogeneous through correlation coefficients between the items and the totalscore of the dimension to which

they belong. The researcher also adopted confirmatory factor analysis in validity of the successful intelligence test for being an indicator of construct validity by identifying the factor structure of the test.

Factor analysis (factor structure) of successful intelligence test: the researcher used the method of confirmatory factor analysis of the first order (non-hierarchical) to verify the structural validity of the successful intelligence test, which in the light of the theoretical frame refers that it is composed of three abilities (analytical, practical and creative). Given that, the assumed model, which is composed of three factors (latent), has been built, and coming out from them arrows heading towards the measured variables (items) of total (12)items in each ability. In application of the test, the researcher relies on a sample of (400) students, and on the statistical program (LISREL) in the analysis of the data.In the light of factor analysis, according to the correlation indicators between the heterogeneity matrix of the items in the analysis and the assumed matrix in the light of the theoretical framework, it was showed lack of a good fit because the value of Chi square is (893.421) with freedom degree of (456) and is statistically significant as well as the other fit indicators were also not acceptable, including the apparent standard regression weights on the arrows that link the latent variable with each of its items, known as the coefficient of validity or saturation, where the validity of saturation of the items can be judged in the light of the critical ratio (C.R.) that indicates significance difference between the item's effect (standard regression weight) and the zero effect. It was showed that the (C.R) was statistically insignificant for the item (5) of the first latent variable (analytical ability), with a (C.R) value of (1.299). Also the item (18) was statistically insignificant of the second latent variable (practical ability), with a (C.R) value of (1.024). Finally, the item (35) was also statistically insignificant because the value of (C.R) was (1.049) of the third latent variable (creative ability), as shown in figure (1).
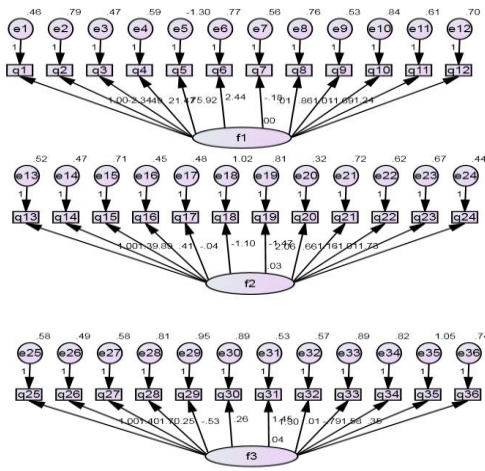
Figure (1): confirmatory factor analysis of the first order (non-hierarchical) of Sternberg's successful intelligence test

After excluding the statistically insignificant items (5, 18, and35) from the abilities (analytical, practical and practical) respectively, the statistical analysis was repeated. As shown in figure (2).
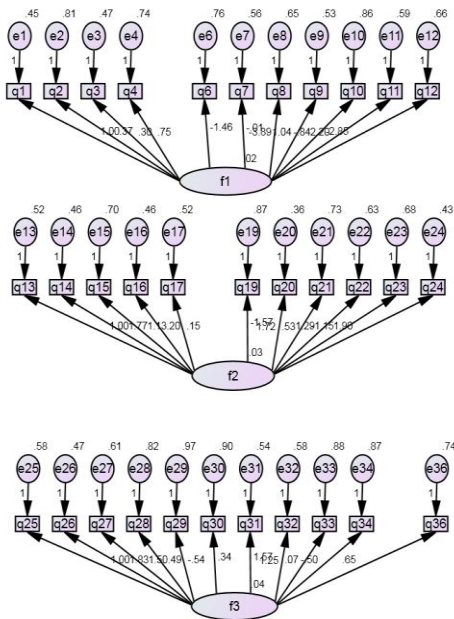

Figure (2):confirmatory factor analysis of the first order (non-hierarchical) of the successful intelligence test in its final form

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To identify the standard regression weights which are known as the coefficient of validity or saturation that can be judged in the light of the critical ratio (C.R.) that indicates significance difference between the item's effect (standard regression weight) and the zero effect, it was showed that all items' saturations are statistically significant because the value of (C.R.) is greater than the tabular value of (3.291) at the level of (0.001), as shown in table (2).

Table (2)

Values of (C.R.) for the significance of the saturation of items of Sternberg's successful intelligence test

items of analytical ability	CR value	items of practical ability	CR value	items of creative ability	CR value
1.	4.119	13.	4.578	25.	3.888
2.	4.034	14.	4.821	26.	3.567
3.	4.259	15.	4.307	27.	4.099
4.	4.112	16.	4.551	28.	4.741
6.	4.510	17.	3.998	29.	4.444
7.	4.763	19.	4.210	30.	4.001
8.	4.458	20.	4.654	31.	3.995
9.	4.316	21.	3.790	32.	4.082
10.	4.988	22.	4.672	33.	4.401
11.	4.397	23.	3.921	34.	4.035
12.	4.155	24.	4.732	36.	4.216

It was also showed that the indexes of fit quality indicate that there is a reliable fit case, as follows:

1- The ratio between Chi square and freedom degree: if it was less than (5),the model is accepted, and if it was less than (2), the model is a perfect fit to the data. In the current factor analysis, the ratio between Chi square value and freedom degree is (2.011). This indicates that the index is accepted as a fit quality.

2- Goodness of Fit Index (GFI): it measures the amount of variation in the analyzed matrix by the model in question, and thus corresponds to the multiple correlation coefficient square in the multiple regression analysis and its value is between (1-0). This high value indicates that the model fits better to the sample data. The value of (GFI) is (0.932) in the current factor analysis and this index is acceptable.

3- Normed Fit Index (NFI): the value of this index is between (1-0). This high value indicates that the model fits better to the sample data. The value of (NFI) is (0.901) and this index is acceptable.

4- Comparative Fit Index(CFI): the value of this index is between (1-0). This high value indicates that the model fits better to the sample data. The value of (CFI) is (0.924) and this index is acceptable.

5- Root Mean Square Error of Approximation (RMSEA): this is one of the most important index of a fit quality, if its value is equal to or less than (0.05), the model is a perfect fit to the

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data, and if the value is between (0.05 – 0.08), the model is a greatly fit to the sample data, and if its value is greater than (0.08), the model is rejected. It is showed that in the current confirmatory factor analysis the index (RMSEA) is (0.055), that is, the model is a greatly fit to the sample data, (Chan, etal, 2007:53-66).

In the light of confirmatory factor analysis of the first order (non-hierarchical) as an index of construct validity of Sternberg's successful intelligence test. It was found that the factor structure of the test has produced three latent factors (analytical, practical and creative), and each factor contains (11) item, that is, the final version of the triarchic intelligence test is composed of (33) items distributing into three abilities (analytical, practical and creative) by (11) item per ability.

Final description of Sternberg's Triarchicintelligence test: in the current research, Sternberg's Triarchic intelligence test, in its final version after identifying its factor structure, is composed of (33) items, after excluding three items distributing into three abilities (analytical, practical and creative) by (11) items per dimension. Thus, the highest possible total score for each ability is (11) scores, and the lowest total score is (zero) with hypothetical mean of (5.5) score.

Statistical methods: in the current research, the researcher used the proper statistical methods of confirmatory factor analysis to identify the factor structure of Sternberg's successful intelligence test using the statistical program (LISREL).

RECOMMENDATIONS

The researcher makes some recommendations to the Ministry of Education as follows:

1- To work on appointing a qualified psychological counsellor,and to benefit from the diagnosis of students by Sternberg's successful intelligence test.
2- To instruct adolescent students (in the preparatory stage) towards the development of the type of abilities and intelligence they possess, through educational curricula and activities containing study subjects, and through

cultural and educational programs within the educationaland pedagogical institutions that develop the student's intelligence.
3- To inform the teaching staff about the importance of the abilities contained in the intelligenceto accustom their students and train them through the teaching methods they use, which emphasize thinking and creativity, not indoctrination and automatic memorization.
4- All researchers have to use Sternberg's successful intelligence test after identifying its factor structure.

SUGGESTIONS

The researcher suggests conducting some studies, including:

1- To standardize Sternberg's successful intelligence test among preparatory school students.
2- Counseling program to develop Sternberg's successful intelligence of preparatory school students.
3- Sternberg's successful intelligence and its relation to some variables (sex, specialty and class) of preparatory school students.

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