

Development and Standardization of Swanson's Reading Metacognition Test (1996)

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ABSTRACT

The present research tries to develop and standardize Swanson metacognition test (1996). Statistical population of this research was all guidance school students (12, 13 and 14 years old) that studied in Mazandaran Province schools in the academic year 2010-2011. A sample of 990 people was chosen through multi-step accidental sampling method from both genders. Measurement tool was Swanson's metacognition test (1996). This test contains 20 questions and 20 other questions were also added to the test. Tests standardization method which is a common method was used to analyze results. Reliability was estimated by Chronbach's alpha to be 0.802. the results of main components analysis and oblimin rotation showed that the test is saturated with 6 factors and determine 30.3 percent of the total variance. The six factors including special strategies, homework targets nature, existing information nature, special competencies, general strategies and motivation and deprivations. Finally, percent norms and T were prepared for this test.

KEYWORDS: metacognition, feasibility, validity, reliability, norm.

INTRODUCTION

Statement of the problem

In today's world the role of cognition and metacognition and advantages of competencies teaching and metacognitive strategies is very clear and it has been the subject of study in many researches throughout the world. In a metaanalysis conducted to study the impacts of metacognitive teaching on comprehension (Haller.child and walberg, 1998) in which 20 researches during 1975-1986 were investigated, mean size effect was 0.71. These studies proves the definite impacts of metacognitive knowledge on improving the quality of study comprehension. Recent studies have shown that learners who have knowledge about metacognition are more competent than those learners who are not aware of metacognition and have better performance (Garner and Alexander, 1989; Perssley and Ghatala, 1990). Metacognitive knowledge refers to our knowledge from our mind and its performance. Metacognitive knowledge includes knowledge about self, homework and strategie. (1993), or we can say a part of our knowledge about the world that is related to cognitive subjects makes up metacognitive knowledge. This kind of knowledge is learned through experience and is saved into long-lasting memory. In Flawell opinion, metacognitive knowledge has been made up of 3 categories of self, homework and strategy and its size depends on the combination or interaction among these 3 categories. Metacognitive plays a fundamental role in learning. Study of successful learning is important in investigating metacognitive activity and determining metacognition effective components (Swanson, 1990). Those students that have internal powerful motivations for learning, use complex processes like expansion or organizing (Pintrich, 2003).

Yip (2007) came to this conclusion that lack of cognitive and metacognitive competencies in learning can affect all other advantages of favorable educational environment and even intelligence abilities and psychological and physical health of individuals in an adverse way and on the other hand, if it is efficient, it can reduce academic motivations of students.

One of the most difficult problems ahead of researchers who study metacognition is the fast and valid measurement of learners. Since 1967 when Flawell introduced metacognition, many researches were conducted to remove this problem. Paris in 1978 prepared a questionnaire with 18 questions that were asked orally. The questions of this test measured 3 categories of metacognitive knowledge. In self category, a person's abilities in studying were investigated. They had tried to measure effects of age, motivation, gender, special competencies, study abilities and environmental restrictions in self category. Homework category questions measured exam knowledge, story length, and speed, selection of paragraph structure goals and unfamiliarity of text. Strategy variable investigated awareness of reading again, deduction and revision. The mentioned test was grueling and also difficult to implement and gather data and extraction of factors affecting metacognition. Paris and cras in 1988 developed a new measurement tool for metacognition with preparing 15 open questions.

One of the latest metacognitive questionnaires is a list 52 multi-choice questions. This questionnaire can be easily applied to adults and teenagers (1994).

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Swanson's 20-question questionnaire is another questionnaire that has been extracted from Paris and Mayer questionnaire. This test tries to investigate metacognition role in reading and comprehension. When we investigate metacognitive measurements history, we come to an evolutionary trend. This study shows that questionnaires open form has turned into multi-choice questions.

Therefore, it seems necessary to prepare and standardize a valid test as an appropriate tool for measuring personal abilities and directing his/her learning towards metacognition. In Iran and especially in Mazandaran province, any research has not been done in this field and experts must pay more attention to this new and important subject. The current research tries to develop and standardize Swanson's study metacognition test. In this test, some items including feasibility study, validity, reliability and norm preparation have been considered and it has been tried to answer the following questions.

- 1) Does Swanson's metacognition test have enough validity?
- 2) Does Swanson's metacognition test have enough reliability?
- 3) Are the questions of the metacognitive test saturated with special factors?

RESEARCH METHODOLOGY

Hence the present research tries to investigate Swanson's metacognition test feasibility, validity and reliability, therefore the current research is of exploratory type.

Statistical population of this research was all guidance school students (12, 13 and 14 years old) that studied in Mazandaran Province schools in the academic year 2010-2011.

In order to prepare necessary conditions to do standardization test and calculate norm and implement factor analysis, at least 500 people from each gender and totally about 1000 people must have been chosen as sample that were chosen through multi-step accidental sampling method. These people were chosen from 4 districts and 12 schools and 48 classes accidentally. 447 people were male (47.8 percent) and 485 people (52.2 percent) were female.

279 people were grade 1 (30%), 230 people were grade 2 (24.8%), and 420 people were grade 3 (45.2%) in guidance schools. Data gathering tool was Swanson's metacognition test (1996). This test contains 20 questions and 20 other questions were added to the test and a 40-question test is prepared so that if some of the questions were eliminated during test, the test validity is not damaged. Therefore this scale has 40 questions each with 4 questions that include comprehension fundamental activities, relationship with former information, and attention to ideas, critical evaluation, comprehension revision and deduction.

It has been recommended in test instructions that the performer of the test must read out loud each question and its choices and after the respondents answered the question, performer read the next question. With this method, test time will be almost the same for all respondents. The above instruction was exactly implemented in all test schools.

To analyse data, the common method of tests standardization was used.

- 1- Common descriptive statistical methods like frequency distribution, central tendency indices, and dispersion indices were used to determine group's characteristics.
- 2- Chronbach's alpha was used to determine internal cooperation and questionnaire's validity.
- 3- Factor analysis (principal-component analysis) was used to measure the validity of metacognition test.
- 4- After principal-component analysis and in order to determine the fact that how many factors saturate the test, perpendicular rotation was used.

Research findings

In this research, validity means internal coordination of the test or interference of all questions from an aspect of a common feature (called metacognition abilities).

Reliability factor of all 40 questions which was measured by Chronbach's alpha was 0.802. Comparison of each question with total point reveals that apart from question number 30, all other questions correlation with total point is significant. The highest correlation is related to question number 26 (0.495) and the least correlation is related to question number 14 (0.127). Correlation coefficient for question number 30 is 0.006 and if it is eliminated, test validity increases to 0.807.

It must be mentioned that question number 30 was eliminated due to weak correlation and also questions number 18 and 24 were eliminated due to lack of factor loading.

Reliability coefficient (=Chronbach's alpha) for 37 questions was 0.769. reduction in number was due to reduction of test length because test reliability has a direct relationship with test length.

Factor analysis: data obtained from tests are numbers that are correlated to each other with different degrees, i.e. there exist overlap and interference between them. These numbers must be analyzed in order to make a fundamental structure so that few but more fundamental dimensions are identified for the characteristics under study. The large and complex structure of factor analysis and principal-component analysis was used to reach this goal (Zhendaik, 1981). In the present research, principle-component analysis was used to answer the

question "whether metacognition test of Swanson (1996) is saturated with one or more general factors or not". In this method, squares on the diagonal (correlation matrix) receive number 1, which contain error variance in addition to common and private variance. This method tries to find a structure that describes all variances of variables under study (Houman, 2008).

oblimin rotation was also used in this study in order to identify factor(s) that possibly make up the infrastructure of this test and also in order to determine a simple structure for the test.

The main motivation for this rotation was correlation between test factors.

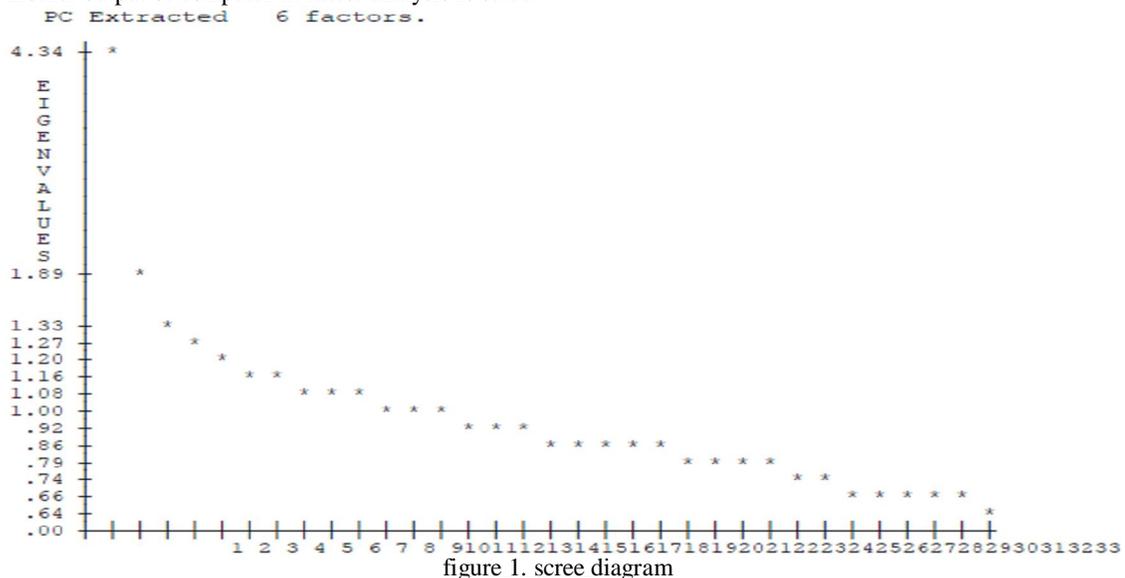
It must be mentioned that it is necessary to study two subjects before implementing a factor analysis: 1) sampling adequacy and 2) certainty about the fact that correlations matrix that is a base for factor analysis is not zero in population. KMO (Kaiser Meyer Olkin measure of sampling) size reflects adequacy of sampling. Small number of KMO shows that the correlation between variable pairs cannot be described through other variables, and therefore factor analysis might be inappropriate. Cerney and Kaiser (1977) believe that when KMO is more than 0.6, factor analysis can be done easily and the higher is this number, the easier will be factor analysis. In order to verify the fact that whether correlation matrix is zero or not, Bartlett test sphericity was used. This test rejects H0 hypothesis, which says identity matrix, i.e. a matrix with 1 on main diagonal and zero on other elements, is correct. This test investigates the hypothesis that correlation matrix is relate to a population with non-closed variables. In order to have a useful and significant factor model, it is necessary to have correlated variables, otherwise there is no reason for describing factor model. If the hypothesis: variables do not have relationship with each other is not rejected, then application of factor analysis will be under question and need to be revised. As it can be seen in table 1, KMO for correlations matrix resulted from metacognition test is 0.855 and statistical index of Bartlett test sphericity is 30171371 which is significant even beyond $p=0.001$. therefore it can be concluded based upon both indices that implementation of factor analysis based on correlation matrix is justifiable. Moreover, the initial output of computer shows that determinant of correlation matrix is a non-zero number (0.002) which shows that factors extraction based on these data is trustable.

Table 1. KMO quantities, determinant and Bartlett test sphericity of Swanson's developed metacognition test (1996).

p	df	value	Statistical index
-	-	0.002	determinant
-	-	0.855	KMO
0.000	780	30171371	Bartlett

In implementing factor analysis for Swanson's developed metacognition test (1996), 3 main indices were considered to determine the fact that how many factors saturate the test constituents.

1) eigen value, 2) variance ratio described by each factor 3) eigen values rotated diagram which is called scree. Analyses showed that eigen value for 13 factors is greater than 1. Common variance covering percentage between variables for 13 factors, describes 50.6 percent of all variances of variables altogether. The first factor with eigen value of 4.337 justifies 11.7 percent of all variances of variables. Another output of computer in factor analysis is scree.



This diagram shows a scetch of total variance described by each variable in which large factors are in the above and other factors are besides each other with decreasing slope.

It can be deduced from scree sketch that the first factor's share is more eye-catching than other factors' share in test questions variance. Using this diagram, 6 factors can be used to extract fundamental factors of metacognition questionnaire. These 6 factors describe 30.3 % of total variance.

It must be mentioned that some researchers have regarded coefficients of higher than 0.30 or even 0.40 as important in defining factors and regarded less coefficients as zero (accidental factor) in studying on the nature of relationship between variables. In paraphrasing the factors, Jonz (1954) used 0.30 as the least value of this coefficient, Houman (1989) took 0.35 and Reynolds et al (1988) considered 0.40 as the least acceptable value. The present research takes 0.30 as the least acceptable value for coefficient, of course there is no doubt when a question loading factor increases, impact of that question will be more in determining that factor but it must be noticed that because the questionnaire under study is a combination of new questions that have been used for the first time in guidance school students of Mazandaran province, it is necessary to be more cautious in choosing questions. Therefore, the minimum value for eliminating and keeping factors was chosen 0.30 and description and denoting the factors was carried out in view of loading factor of questions in which extracted factors had the greatest share.

Hence, it was necessary to eliminate some of the questions that had weak recognition power or did not have any significant loading factor on factors so that 1) matrix determinant is not zero and its inverse is computable and factor results are interpretable.

2) questionnaire structure is simpler and clearer.

3) its structure matches with theoretical model.

4) egregious difference between lowest and highest common value is eliminated.

5) scree sketch determines factors with higher clarity and finally, 6) produced matrix based on extracted factors does not have fundamental difference with the first correlation matrix.

Question 30 was eliminated due to weak correlation in reliability coefficient calculation. Other questions were not eliminated because they had enough loading factor. Implementation of factor analysis for several times (through trial and error and also scree sketch presented in figure 1) showed that the best model for satisfying above mentioned goals is a model with the least loading factor 0.30 with 6 factors.

Factor matrix obtained through principle-component analysis showed that:

1) 22 questions have a positive loading factor greater than 0.30 with the first factor

2) Correlation exists between 5 questions with second factor and 5 questions with the third factor and 5 questions with fourth factor and 2 questions with the fifth factor and four questions with the sixth factor and have tendency to be bi-polar because almost half of their loadings are positive and the other half is negative.

3) 10 questions factor loading are concentrated on two factors which show 10 questions have relative complexity and the other questions are all pure and related to only one factor.

Eigen-values for the 6 extracted factors, covering percent of variance for each factor and their compressional percentages are summarized in table 2.

Table 2. final characteristics of extracted factors

factor	Eigen-value	Variance percentage	Compressional	variance percentage
1	4.337	11.7		11.7
2	1.887	5.1		16.8
3	1.331	3.6		20.4
4	1.271	3.4		23.9
5	1.203	3.3		27.1
6	1.161	3.2		30.3

As it can be seen in table 4, the least eigen value is 1.116 that matches with Keyser's acceptable criterion. All 6 factors describe 30.3 percent of all variance of variables.

Because factors matrix is not rotated and its factor loadings do not yield a significant structure, extracted factors were transferred to new axes using oblimin rotation so that it will be possible to discover questionnaire overall shape and identify a simpler structure which shows important and clear directions to reach interpretable solutions. The structural matrix obtained after oblimin rotation has been shown in table 3.

Table 3. rotated structural matrix of metacognition developed test questions set (1996) using oblimin method

question	F1	F2	F3	F4	F5	F6
15	0.546					
17	0.538					
26	0.511	-0.366				
23	0.460					
16	0.394					
20	0.355					
13	0.346					
38		-0.601				
39		-0.576				
32		-0.566				
35		-0.504				
34		-0.498				
37		-0.470				
28		-0.466				
31		-0.459				
33		-0.405				
29		-0.397				
36		-0.369				
40		-0.332				
10			0.503			
11			0.477			
9			0.463			
14			0.462			
7			0.391			
25	0.341		0.370			
6				-0.596		
5				-0.582		
4				-0.521		
2					0.637	
1					0.621	
3					0.440	
22	0.319				0.393	
12			0.320		0.370	
8						-0.524
21						-0.481
27						-0.479
19						-0.441

Table 3 results show that:

- 1) Questions number 18, 24 and 30 do not have factor loadings and eliminated from questions list.
- 2) Questions number 12, 22, 25, and 26 are focused on 2 factors and have relative complexity.
- 3) Other questions are very pure and lack complexity.
- 4) The maximum coefficient in structural matrix (correlation of each question with factor) was 0.637 was related to question number 2 (it is better when you finish a story) and fifth factor of general strategy, and the minimum coefficient was 0.332 related to question number 40 (if you want to prepare yourself for a lesson) and second factor of homework goals nature.

as it can be seen, a set of questions that are correlated with one factor, form a semi-test that have factor loadings of higher than 0.3. in 6-factor figure and based on subsets of metacognition knowledge categories, the results can be classified as follows:

the first factor that includes questions 13, 20, 16, 23, 26, 17 and 15 is related to special strategies from strategy subsets. This variable demonstrates memory improvement tactics and study skills.

The second factor that contains questions 40, 36, 29, 33, 31, 28, 37, 34, 35, 32, 39, and 38 is related to homework goals nature from homework subsets. This variable demonstrates an individual's awareness of what is wanted in homework and the homework's goal.

The third factor contains questions 25, 7, 14, 9, 11, 10 and is related to existing information nature from homework subsets. This variable demonstrates the nature of information that we face in each homework or cognitive situation and affects learning quality.

The fourth factor that contains questions 4, 5 and 6 is related to special competencies from self variable subsets. This variable depicts the characteristics of a successful reader.

The fifth factor contains questions 12, 22, 3, 1, 2 and is related to general strategy from strategy subsets. This variable describes selection of suitable educational strategies and usefulness of selected strategy.

The sixth factor contains questions 19, 27, 21 and 8 and is related to motivation and restrictions are from self variable subsets. This variable describes metacognitive information connected with personal abilities perception and the quality of overcoming restrictions.

In order to paraphrase and interpret each individual's points, it is necessary to move his points to a new scale so that a general framework is prepared for point's comparison. This scale which is called norm intends to describe an individual's relative condition and status within a reference group. A suitable reference group is one with which every individual can be compared (Houman, 2007). Norm has the following necessary conditions:

- 1) A test for which a norm is prepared must have enough validity and reliability and measure exactly what is intended to.
- 2) The test must be implemented on the sample group.
- 3) Sample group must be large enough.
- 4) The test must have instructions so that it can be conducted similarly for several times.

In the present research, because there was no significant difference between performances of girls group and boys group and also between 3 age groups of 12, 13 and 14, therefore only percentage norms and standard norms were estimated for the entire group.

DISCUSSION AND CONCLUSION

Cognition means knowledge in common language but psychologically, it means thinking flows, learning, organization, and storage and information application. It is defined as mental abilities, perception, memorizing, reasoning , ... which have been organized within a complex system and metacognition is a person's knowledge about self-cognitive processes and flows and contains performing, arranging, and coordination of these processes. Metacognition is our knowledge of our cognitive system, i.e. it refers to quality of knowledge about knowledge.

Cognitive and metacognitive strategies are those activities and practical and mental skills that are used to think and learn, arrange our thinking and learning activities and try to remove defects through investigation, planning, testing, reviewing and revising.

In recent years, education with the aim of progressing metacognitive skills has been emphasized in students and the current research tried to develop and relate metacognition theories to development and standardization of metacognition test of Swanson in reading. The mentioned test is the result of many researchers and psychologists researches that has been evolved in many years. In this research, test length was increased from 20 questions to 40 questions in order to increase validity.

The following questions were tried to be answered in this research:

- 1- Whether Swanson's metacognition test (1996) has enough validity or not?
- 2- Whether Swanson's metacognition test has enough reliability?
- 3- Whether metacognition test questions have been saturated with factors?

In order to answer the first question, Chronbach's alpha was used and in the first step, it was calculated to be 0.802 and after investigating test questions, questions with low identification power were deleted, therefore question number 30 that lacked enough correlation with test was deleted and also questions 18 and 24 were eliminated due to lack of factor loading and test final validity was 0.769 after these eliminations, because test length was reduced.

Metacognition researchers believe that one of the most difficult problems they face is valid and quick investigation of metacognitive understandings of learners. Moreover, Swanson (1996) who is the designer of metacognition test believes that metacognition tests have low validity. Considering the mentioned restrictions in conducting this research, validity of the research seems to be acceptable.

20-question form of this test showed low validity. Sabzianpour (1993) estimated validity of this test for grade 2 female students to be 0.44 after eliminating 4 questions. Swanson (1996) reported the validity of test to be 0.87. Khavandi Zad Aghdam (2000) reported a validity of 0.80 after increasing the number of questions to 50 for male students of guidance schools in Tehran.

In order to measure construction reliability and answering to the second and third questions, factor analysis was conducted using principle-component analysis for 37 questions. 6 factors were extracted through factor analysis and oblimin rotation and these 6 factors describe 30.3 percent of the overall variance where the first factor share was 11.7 percent with an eigen-value equal to 4.337. Before conducting factor analysis, sampling adequacy was studied through KMO and H0 was rejected through test and identity matrix in population proved to be incorrect.

Factor analysis showed that this scale has enough reliability and is saturated with 6 factors. Questions number 26, 22, 25 and 12 whose factor loadings were concentrated on two factors are questions with relative complexity and they can be investigated in later researches. oblimin rotation was used to simplify extracted factors. The following results were obtained after analyses:

The first factor has strong correlation with 7 questions and describes special strategies. This factor, along with the third factor, i.e. general strategies, is placed in strategy category which is one of the main categories of metacognitive knowledge. Berg (1983) believes that special strategies are related to speaking with oneself, memory improvement tactics, study skills, organizers, underlining important contents and taking notes.

The second factor has correlation with 12 questions and describes homework goals. This depicts homework's goal and an individual's awareness of what has been asked in the homework. Children must know that some cognitive actions need to be practiced more and some of them are easy to do. For example, remembering a story is easier than telling the story with its writer's own words (Flawell, 1979).

The third factor has correlation with 6 questions and depicts existing information nature. This factor has the same direction with the second factor i.e. favorable goals nature and both are considered to be subsets of homework category. These information can be little or much, familiar or unfamiliar, vast or compression, well- or badly-organized, newly-styled or repetitive, interesting or boring, reliable or unreliable. Metacognitive knowledge states that how such a variable can be applied to cognitive action and how it must be managed so that you can reach your goals successfully. For example, children need to learn. Sometimes we do not have enough information about others and in such situations; we must not judge others (Flawell, 1979).

The fourth factor has correlation with 3 questions and is named special competencies. This variable is a subset of self variable. Self variable contains knowledge and beliefs that sees human as a cognitive processor. A person's knowledge about himself is placed in this category and children must know about their long-lasting and short characteristics that affect their behaviors. Moreover, students must be able to evaluate their own abilities in a reasonable way (Flawell 1977 as quoted from Meyer and Parris, 1978).

Meyer and Parris (1978) regard special competencies as one of the aspects of successful reading. Children must be aware of skillful reader special competencies.

The fourth factor has strong correlation with 5 questions and describes general strategies. This factor, along with seventh factor, is subsets of strategy category. Metacognitive strategies affect cognitive performance in different settings. Mlot (1990) showed in a study that metacognitive knowledge has relationship with comprehension and metacognition improvement affects reading abilities. Berg (1983) believes that there is relationship between current information and appropriate strategies selection.

The sixth factor has correlation with 4 questions and describes motivation and restrictions. This factor is placed in metacognitive knowledge category along with special competencies. This factor includes metacognitive information related to personal abilities perception and it also includes conditions and restrictions. The result of such a knowledge is that learners can apply their powers (Meyer and Parris, 1978).

It must be mentioned that the results of factor analysis might not be generalizable to other samples.

Hence this research was conducted only in guidance schools of Mazandaran province, its results cannot be generalized to other academic grades or other provinces. Therefore many more researches are necessary in order to make the results generalizable to other samples. It is also necessary to do a similar research in vaster level in order to achieve more standard and compressive norms.

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