International Journal of Applied Social Science
Volume 6 (3), March (2019) : 619-627
Received : 14.01.2019; Revised : 28.01.2019; Accepted : 13.02.2019

RESEARCH PAPER
ISSN : 2394-1405

Construction and Standardization of Higher Order Thinking Test in Mathematics

RAM MEHAR*[1] AND NAVDEEP SANWAL[2]
[1]Associate Professor and [2]Assistant Professor
[1]Department of Education, USOL, Panjab University Chandigarh (U.T.) India
[2]Rayat College of Education, Railmajra, Shaheed Bhagat Singh Nagar (Punjab) India

ABSTRACT

There are many alternates to assess the cognitive domain of knowledge and thinking. Many of the teachers/researchers tries to assess it through teacher made objective/subjective type achievement tests, some of them try to assess through standardized tools but in the present paper investigators tried to construct and standardized the subjective type Higher Order Thinking Test in Mathematics for 7th class students. This test is developed not only to assess the cognitive domain of the learners at lower level but at higher level of thinking. The detailed process of the construction and standardization of higher order thinking test in mathematics for 7th class. Higher order thinking in mathematics refers to one's ability to analyze, evaluate and create new ideas in mathematics. The test initially consisted of 45 items after review and evaluation by subject experts, which were reduced to 38 in the first try out and then finally to 25 items in the final draft after the item analysis. The test-retest reliability of the test was computed to be 0.84. Content validity was calculated and the scale was found to be valid. Test items were evaluated subjectively by using a general scoring rubric.

Key Words : Higher Order Thinking, Mathematics, Construction and Standardization of Test

INTRODUCTION

Bloom (1956) described cognitive domain is the most-used of the domains, refers to knowledge structures (although sheer "knowing the facts" is its bottom level). It can be viewed as a sequence of progressive contextualization of the material. Cognitive domain presents a hierarchical structure of complexity, over six levels. The lowest three levels start with knowledge, comprehension and application, while the three highest levels are (in ascending order) analysis, synthesis and evaluation. In order to avoid confusion due to the notion of knowledge being lowest in the taxonomy, the classification-concepts were later revised into remembering, understanding and applying at the lower level and analyzing, evaluating and creating at the higher levels.

Situations, skills, and outcomes are the areas that challenge the thinker to think at higher order thinking (Crowl *et al.*, 1997). According to Bloom (1956) and Kauchak and Eggen (1998) in each of Bloom's three taxonomies (cognitive, affective, and psychomotor), lower levels provides a base for higher order learning. It is very clear from the taxonomy that comprehension and application form linkages to higher order skills; here, the learner uses meaningful information such as abstractions, formulas, equations, or algorithms in new applications in new situations. According to revised Bloom taxonomy higher order thinking skills include analysis, evaluation and creation that require mastery of previous levels. The process of higher order thinking involves breaking down complex material into parts, detecting relationships, combining new and familiar information creatively within limits and combining and using all previous levels in evaluating or making judgments (McDavitt, 1993).

According to Tomei (2005) higher order thinking

How to cite this Article: Mehar, Ram and Sanwal, Navdeep (2019). Construction and Standardization of Higher Order Thinking Test in Mathematics. *Internat. J. Appl. Soc. Sci.*, **6** (3) : 619-627.

skills involves the transformation of information and ideas. This transformation occurs when students analyze, combine facts and ideas and synthesize, generalize, explain, or arrive of some conclusion or interpretation. McDade (1995) defines higher order thinking skills as the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/ or evaluating information gathered from, or generated by observation, experience, reflection, reasoning, or communication as a rubric to belief and action. According to Haladyna (1997) higher order thinking skills are described as understanding of facts, concepts, principles, and procedures.

Higher order thinking are also termed as critical or strategic thinking, it can be explained as the ability to use information to solve problems, analyze arguments, negotiate issues or to make predictions (Petress, 2006). Protheroe (2007) suggested that in mathematics classroom, teacher and students must do the following things to get an effective environment for higher-order thinking such as: (i) Actively engage in doing mathematics (ii) Use multiple representations to communicate mathematical ideas (iii) Make interdisciplinary connections (iv) Share mathematical ideas with each other (v) Solve challenging problems (vi) Use manipulative and other tools.

Miri *et al.* (2007) proposed that the three teaching strategies for enhancing higher order thinking skills such as: (i) Encourage learners in classroom to cope with relevant situations (ii) Encourage learners to ask questions and present their own solutions (iii) Encourage learners to learn in cooperation or in group.

Kauchak and Eggen (1998) found that these strategies contribute for enhancement of higher order thinking skills, such as: (i) Articulate learning goals, objectives, learning tasks, content ideas and skills, assessment activities and learning aids, (ii) Establish organized activities and routines, (iii) Explain the task clearly (iv) Give transition signals to communicate that one idea is ending and another is beginning and (v) Provide feedback at frequent intervals with a corrective feedback to clarify incorrect or partially incorrect responses. Resnick (1987) explained that, although higher order thinking is complex and may not be easily defined; its characteristics are actually quite easily observed in practice. In the present study investigator further tried to elaborate the challenges.

A higher order thinking test for measuring the performance of VII class students at higher level in mathematics, the prescribed syllabus of Central Board of Secondary Education, New Delhi, is one that provides for translating test scores into statement about the behavior to be expected of a person with that score or their relationship to a specified subject matter. There are several concepts associated with higher-order thinking: Critical thinking, problem solving, creative thinking, and decision-making. Lewis and Smith (1993) define higher order thinking as instances in which a person takes new information and information stored in memory and interrelates and/or re-arranges and extends this information to achieve a purpose or find possible answers in perplexing situations. When people use higher-order thinking they decide what to believe and what to do. They create new ideas, make predications, and solve non-routine problems. The educational researchers correlate higher-order thinking with creative and abstract thinking, decision-making, analyzing theories, and active mental construction (Zohar and Dori, 2003). The higher order thinking is a process in which learner try to analyze, evaluate and create new ideas or correlate the new ideas with the old one (Anderson *et al.*, 2001). The higher order thinking test can be designed for the three purposes such as: Firstly, to assess the performance of students at higher level as per revised Bloom's taxonomy *i.e.* at analyzing, evaluating and creating level. Secondly, higher order thinking can be measured to provide information about the instructional treatment which produces that behavior. Thirdly, to compare the higher order thinking level of students in the class and to provide them suitable environment for the enhancement of higher order thinking in the subject of mathematics. Anderson *et al.* (2001) described the higher order thinking skills in the revised Bloom taxonomy diagram have been presented in Fig. 1.

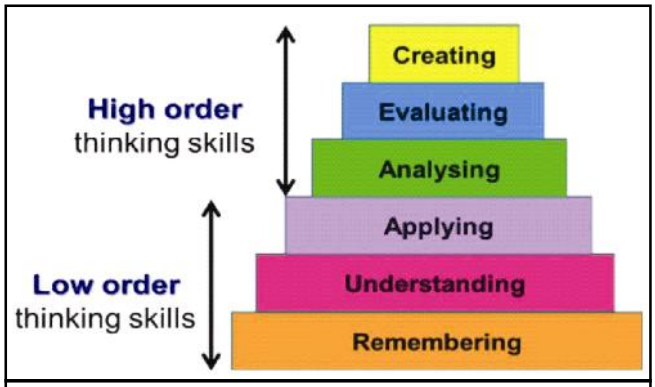

Fig. 1 : Revised Bloom Taxonomy

Popham (1975) maintained that the most important aspect of higher order thinking test is that a well-explicated domain of behaviour is delineated and an individual's performance in relation to his behaviour domain be ascertained. All these components stress the educatiometric and psychometric of higher order thinking test. He suggested the following steps for the construction of higher order thinking test such as: (i) Domain definitions (ii) Generating items (iii) Improving items (iv) Reliability and Validity. These steps are briefly described below:

(i) *Domain definitions:* This is the most difficult and important step in the construction of higher order thinking test. Here, the limits of behaviour that the test items would measure and to which all individual performance would be referenced are to be determined.

(ii) *Generating items:* For any given objective, a number of items may be constructed to have an item pool of close to thousand items. In writing these items, proper care should be taken regarding the coverage of the content, structure of item type and language.

(iii)*Improving items:* In order to ensure that the entire class of learner behaviours had been circumscribed, a try-out should be conducted. The first draft of higher order thinking test was given to subject experts of mathematics, who have been teaching mathematics from more than five years to VII class. The second draft of higher order thinking test was administered to a selected sample of students who have already studied the content without any imposition of time limit. The answer-sheets were scored with the help of the scoring rubric prepared for the test. The item analysis is then carried out and few items may be modified or rejected in this process. The simple and concise directions, including purpose of the test and procedure of recording the answer are developed by the investigator.

(iv) *Reliability and validity:* The idea of reliability is as crucial for higher order thinking test as for all other tests. Yet for higher order thinking test, there are some important cautions that need to be taken care of and a somewhat different way of conceptualizing certain reliability procedures. Popham (1975) "suggested that when marked range restrictions are present it may be necessary to employ less sophisticated but more meaningful reliability estimates. Less fancy methods of calculating consistency might be used, for instance, rather than using correlation methods, simple computation of the percentage of student scores". Gronlund (1977) "opined that the type of validity of greatest importance for higher order thinking test is content validity. Hence, the content validity of the test must established by relating the task to instructional objectives". So from the above point of view, the development of higher order thinking test in mathematics was a crying need. The investigator could not find an appropriate standardized higher order thinking test in mathematics pertaining to the content and objectives selected for the study. The investigator felt the need to develop higher order thinking test to evaluate students, analyzing, evaluating and creating abilities of students in the subject of mathematics. The objective is simply to see whether the students are performing with higher level of thinking *i.e.* analyzing, evaluation and creating or just on the lower level of thinking *i.e.* remembering, explaining and applying.

The process of construction of higher order thinking test in mathematics was carried out in three phases which are:(i) Planning (ii) Construction (iii) Standardization of the test.

(i) *Planning Phase:* The planning phase includes deciding the units of content, the instructional objectives related to the content, the type of test items to be included in the test and the weight age to be given to various aspects. Hopkins *et al.* (1990) observed that the planning stage of a test should include the nature of the test, test items and a statement of conditions under which it will be administered. After studying the mathematics text book prescribed syllabus by National Council for Educational Research and Training, New-Delhi for VII class students, content area was identified and the instructional objectives were specified in behavioural terms. The specification of higher order thinking test has been prepared. The mathematics teachers who had been teaching this subject to class VII were consulted while identifying the contents. The unit-wise details of the selected content of mathematics have been given in Table 1.

Table 1 shows that the five units of mathematics subject of class VII were selected from the prescribed syllabus of Central Board of Secondary Education, New Delhi and few questions were prepared on each of the above topic. A blue print of the same was prepared which included the specifications of the topics, number of objectives for various topics. The number of test items consisting of analyzing, evaluating and creating domain was included in this test. The specifications of the higher order thinking test in mathematics has been presented in Table 2.

Table 1 : Unit-wise details of selected content of mathematics

Sr. No.	Units	Sub Topics
1.	Number System	(i) Knowing our numbers (Integers). (ii) Addition and subtraction. (iii) Multiplication and division. (iv) Fractions and rational numbers: Multiple of fractions, fraction as an operator.
2.	Ratio and Proportion	(i)Ratio and proportion (ii) Percentage (iii) Converting fraction and decimals into percentage and vice-verse.
3.	Geometry	(i) Understanding shapes: Pairs of angles (ii) Properties of triangles: Angle sum property (iii) Symmetry: Reflection symmetry, rotational symmetry (iv) Representing 3-D in 2-D
4.	Mensuration	(i) Area of Rectangle, square and (ii) Its applications
5.	Data Handling	(i) Collection and organization of data (ii) Mean , median, mode of ungrouped data

Table 2 : Specification of the higher order thinking test in mathematics

Sr. No.	Units	Objectives	Type of Test Items			Total
			Analyzing	Evaluating	Creating	
1.	Number System	11	6	8	7	21
2.	Ratio and Proportion	11	2	2	-	4
3.	Geometry	11	3	3	4	10
4.	Menstruation	12	1	2	3	6
5.	Data Handling	14	-	3	1	4
Total		59	12	18	15	45

Table 2 shows that 45 subjective test items were planned. 12 items were of analyzing type, 18 items were of evaluating type and 15 items were of creating type. Hence, the total 45 subjective items were planned for the first draft of higher order thinking test in mathematics.

(ii) *Construction phase:* It includes writing and editing of actual test items to be included in the higher order thinking test in mathematics. In order to measure the objectives framed, items need to be framed corresponding to every objective. The items in the present test were written in clear and simple language. The items were framed after careful knowledge and complete mastery of the subject matter. The double barreled items and exceptionally lengthy terms were avoided. Later, items were arranged logically and appropriate directions to attempt the test were written for the students. After careful exploration of literature, a pool of 45 items on different dimensions were written and edited. The following points were kept in mind while writing the items:

(a) Items are related to dimensions.

(b) Items were comprehensive to the respondent.

(c) The language of the items was such that the respondents can immediately identify with the situation expressed in the item.

(d) Those items were avoided that could be interpreted in more than one way or about which contradictions could arise.

(e) The number of items selected was greater than to be retained in the scale.

The construction phase of higher order thinking test in mathematics passed through three stages such as: (i) First draft of higher order thinking test in mathematics, (ii) Second draft of higher order thinking in mathematics test in mathematics and (iii) Final draft of higher order thinking test in mathematics.

First draft of higher order thinking test in mathematics:

After the deep study of related literature, discussion with fellow researchers and personnel experience of the investigator, 45 test items were constructed in mathematics for the first draft of higher order thinking test in mathematics. These test items lies under the three different domains of higher order thinking *i.e.* analyzing,

evaluating and creating. The domain wise distribution of test items for the first draft has been presented below in Table 3.

Table 3 : Domain wise distribution of test items for the first draft of higher order thinking test

Sr. No.	Higher Order Thinking Domains	Item No.	Total
1	Analyzing	1-12	12
2	Evaluating	13-30	18
3	Creating	31-45	15
	Total		45

Table 3 shows that out of 45 items of the first draft, 12 items were of analyzing domain, 18 items were of evaluating domain and 15 items were of creating domain.

First tryout and evaluation: In the tryout of the first draft of higher order thinking test in mathematics comprising of 45 test items was given to 8 mathematics teacher/experts who had been teaching mathematics to class VII students for the last five years and to experts with enriched experience in the field of pedagogy and research to critically analyze the test items for the content and language, correct ambiguities if any, check that all the specified objectives were tested, and give suggestions regarding items to be modified, deleted or added. The 8 experts were personally requested by the investigator to go in for serious reflection over every statement and to indicate how the statements were relatively close to the said objectives. The investigators devoted several sittings to consider the judgments of the experts on the test items. Discussions with subject teachers/experts were held individually. On the basis of suggestions made by the mathematics teachers/experts, the higher order thinking test was reframed to prepare the second draft by modifying 8 test items and dropping 7 items. The items were then re-arranged in logical order. The 38 items were retained for the second draft of higher order thinking test in mathematics. On the basis of opinions of subject experts, few items were dropped and modified are as shown in Table 4.

Table 4 shows that upon evaluation by the experts 7 items were dropped while 8 items were modifies in light of the suggestions. Therefore out of 45 items 38 items were retained for the second draft of higher order thinking test in mathematics.

Table 4 : Description of items dropped or modified of Higher Order Thinking Test

Sr. No.	Item No.	Total	Remarks
1.	7, 15, 18, 22, 33, 39, 40	7	Dropped
2.	1, 8, 14, 15, 24, 25, 32, 35	8	Modified

Second draft of higher order thinking test in mathematics:

The second draft of higher order thinking test in mathematics scale consisted of those items which were accepted as such and which were modified or revised taking in consideration the opinions given by the experts. The domain wise distribution of items for the second draft of higher order thinking in mathematics test has been given in Table 5.

Table 5 : Domain wise distribution of test items for the second draft of higher order thinking test

Sr. No.	Higher Order Thinking Domains	Item No.	Total
1.	Analyzing	1-11	11
2.	Evaluating	12-26	15
3.	Creating	27-38	12
	Total		38

Table 5 shows that out of the 38 items, 11 items were of analyzing domain, 15 items were of evaluating domain and 12 items were of creating domain.

– *Second try-out and evaluation:* The second draft of higher order thinking test in mathematics comprising of 38 items was administered to a sample of 60 mathematics students drawn from VII class who had already studied the content, studying in Rayat International School, Ropar for item validity, so as to remove language difficulty, if any. No time limit was fixed for the students to attempt the test but it was found that students completed the test in about 90 minutes. The observations made by the students were noted down and considered in revising the draft of the test. During the try-out, following points were kept into consideration:

(a) The temporal conditions for testing were maintained to the satisfaction of the researcher and the students.

(b) The seating arrangement was free from cheating conditions.

(c) The investigator was always available to the students to answer their queries, if any.

After the test was completed by all the students, the answer-sheets were collected and scored with the help of scoring rubric by the investigators. Stanley and

Hopkins (1972) along with Ebel (1965) have suggested that the application of correction for guessing only when some students have omitted a large number of items. Shaycoft (1979) states that item analysis is not essential for higher order thinking test in mathematics. But still the higher order thinking test in mathematics has to be constructed in a manner that items should not be removed out without a reason after try-out". The identification of items which do not help achieving the objectives is required to be done by following the process of item analysis. After the scoring, the item analysis of the test was done. The items were analyzed qualitatively for content and form and quantitatively in terms of statistical properties. Item analysis usually provided two kind of information on item such as, item difficulty, which helps us decide if the test items are at the right level for the target group and item discrimination, which allows us to see if the individual items are provided information on candidate's abilities consistent with that provided by other items on the test.

The responses of the subjects were scored as per allotted weight-age. The weighted score for each item and for each subject were summated. On the basis of total scores, 27% (16 students) subjects with high scores *i.e.* high group and 27% (16 students) with low score *i.e.* low group were identified. Their scored responses in items of weighted scores for each item were worked out. Item analysis was carried out by employing t-test for 38 items for high and low group. The t-ratio was computed for the higher and lower group to find discrimination power of each item. Thus, the significance of difference between means of scores of high and low group was worked out to find the discrimination power of each item *i.e.* how well each statement could distinguished on the basis of the value of t-ratio, between students with high and low higher order thinking in mathematics. Those items which show a significant difference between high and low group at 0.05 level of confidence was selected for the final draft of higher order thinking in mathematics test. The t-ratio of 38 items has been placed in Table 6.

Table 6 shows that t-ratio for 13 items *i.e.* 3, 6, 7, 10, 12, 17, 21, 23, 24, 27, 31, 32 and 35 were not found significant event at 0.05 level of significance and rest of the items were found significant at 0.05 and 0.01 level of significance. Hence, out of 38 items, 13 items were dropped and 25 items were retained for the final draft of higher order thinking test in mathematics.

Final draft of higher order thinking test in mathematics:

The final draft of the higher order thinking test was formed on the basis of item analysis of second draft. The same criteria were adopted for the item analysis as earlier in the first and second draft, given by Ebel (1965). After the item analysis 13 items were rejected from the second draft of higher order thinking test in mathematics. But on the basis of t-ratio of each item of higher order thinking test in mathematics, 25 items were retained. A list of domain wise selected and rejected items for the final draft of higher order thinking test is given below in the Table 7.

Table 7 shows that the final draft of higher order thinking test in mathematics consisted of 7 items for analyzing, 10 items for evaluating and 8 items for creating domain were included in this test. Out of total 38 subjective items, 25 items were retained, while a total of 13 items were rejected after calculating t-value of each item. So, finally the remaining 25 items were retained for the final draft of the higher order thinking test in mathematics.

Table 6 : t-ratio of high and low group of second draft of higher order thinking test in mathematics

Item No.	t-ratio	Item No.	t-ratio	Item No.	t-ratio	Item No.	t-ratio
1	3.57**	11	4.53**	21	0.62	31	0.65
2	4.15**	12	0.22	22	8.89**	32	1.91
3	0.52	13	2.32*	23	1.92	33	2.60*
4	3.69**	14	3.52**	24	0.15	34	4.82**
5	7.25**	15	2.67*	25	2.05*	35	1.42
6	0.65	16	2.10*	26	3.34**	36	5.07**
7	1.28	17	1.51	27	0.60	37	3.09**
8	2.50*	18	4.37**	28	3.57**	38	2.53*
9	2.43*	19	9.02**	29	2.69*		
10	0.11	20	7.81**	30	5.03**		

*Significant at 0.05 level **Significant at 0.01 level

Table 7 : Selected and rejected items for the final draft of higher order thinking test

Sr. No.	Domain	Items	f	Remarks
1.	Analyzing	1, 2, 4, 5, 8, 9, 11	7	Selected items
		---	---	---
		3, 6, 7, 10	4	Rejected Items
2.	Evaluating	13, 14, 15, 16, 18, 19, 20, 22, 25, 26	10	Selected items
		---	---	---
		12, 17, 21, 23, 24	5	Rejected Items
3.	Creating	28, 29, 30, 33, 34, 36, 37, 38	8	Selected items
		---	---	---
		27, 31, 32, 35	4	Rejected Items

Table 8 : Scoring rubric higher order thinking test in Mathematics

Score	Response to the problem
0	Does nothing
1	Consistently does all or almost all of the following: 1. Offers biased interpretations of evidence, statements. 2. Ignores or superficially evaluates obvious alternative points of view. 3. Argues using fallacious or irrelevant reasons, and unwarranted claims. 4. Does not justify results or procedures, nor explain reasons. 5. Regardless of the evidence or reasons, maintains or defends views based on self-interest or preconceptions.
2	Does most or many of the following: 1. Misinterprets evidence, statements. 2. Ignores or superficially evaluates obvious alternative points of view. 3. Draws unwarranted or fallacious conclusions. 4. Justifies few results or procedures, seldom explains reasons. 5. Regardless of the evidence or reasons, maintains or defends views based on self- interest or preconceptions
3	Does most or many of the following: 1. Accurately interprets evidence, statements. 2. Offers analyses and evaluations of obvious alternative points of view. 3. Draws warranted non-fallacious conclusions. 4. Justifies some results or procedures, explains reasons. 5. Fair-mindedly follows where evidence and reasons lead.
4	Consistently does all or almost all of the following: 1. Accurately interprets evidence, statements 2. Thoughtfully analyzes and evaluates major alternative points of view. 3. Draws warranted judicious, non-fallacious conclusions. 4. Justifies key results and procedures, explains assumptions and reasons. 5. Fair-mindedly follows where evidence and reasons lead.

Administration:

The higher order thinking test in mathematics was designed to administer the individual higher order thinking of the students in mathematics. After the distribution of test booklets along with the answer-sheets, the subjects are required to fill their identifying information on the cover page. They are told to read the instructions given on the cover page carefully. Supervision is needed to clear all their doubts regarding the filling of responses and mode of giving responses before proceeding. The test has the time limit of 50 minutes. They are instructed not to turn the cover page until told to do so. Use the space given to answer the problems. The answers if required can be changed by rewriting it.

Scoring:

Scoring rubric was made and got scrutinized. Problems were evaluated by using five point rubric. The total scores are to be found by adding all the scores to responses. The maximum scores for the higher order

thinking test in mathematics were 100 and minimum was zero. The rubric for the evaluation of test items is as following in Table 8.

Reliability:

Reliability refers to the consistency, stability and repeatability of results *i.e.* the result of a researcher is considered reliable if consistent results have been obtained in identical situations but different circumstances (Twycross and Shields, 2004). Reliability is a measure of the stability or consistency of test scores. You can also think of it as the ability for a test or research findings to be repeatable. For example, a medical thermometer is a reliable tool that would measure the correct temperature each time it is used. In the same way, a reliable math test will accurately measure mathematical knowledge for every student who takes it and reliable research findings can be replicated over and over. Of course, it's not quite as simple as saying you think a test is reliable. There are many statistical methods you can use to measure reliability. For example: Split-half method, Test-retest method, rational equivalence method etc. The final draft of the higher order thinking test in mathematics was administered to students on two different occasions after an interval of 30 days and coefficient of correlation was computed by using test-retest method between the two sets of the scores. So, the test may be considered fairly reliable. The reliability of the final draft of higher order thinking in mathematics test for each dimension has been presented in Table 9.

Table 9 : The reliability of the final draft of higher order thinking test in mathematics

Dimensions	Reliability Coefficient (N=42)
Analyzing	0.91
Evaluating	0.88
Creating	0.74
Total	0.84

Table 9 shows that the reliability coefficient for analyzing, evaluating and creating domain of higher order thinking was 0.91, 0.88, and 0.74, respectively. The overall reliability of higher order thinking test is 0.84. Thus, the final draft of higher order thinking test in mathematics was considered reliable.

Validity:

The degree to which a test measures what it intends to measure termed as validity of the test. In the present test investigator tried to ensure content validity of the higher order thinking test. A test is said to be have content validity if the items chosen correlate with the test specification, which is drawn up through a detailed examination of the subject domain and desired expected behavior outcomes. For the investigator distributed this test to some mathematics teachers/subject experts for review of test items, and their suggestions were taken into consideration and compiled with, as to whether each item appropriately matched the content area and specified expected outcomes; hence the content validity of higher order thinking test can be said to be established.

REFERENCES

Anderson, L.W., Krathwohl, D.R. and Bloom, B.S. (2001). *A taxonomy for learning, teaching, and assessing: A revision of bloom's taxonomy of educational objectives*. Boston, MA: Allyn and Bacon.

Bloom, B.S. (1956).*Taxonomy of educational objectives, Handbook I: Cognitive domain.* New York: McKay.

Crowl, T.K., Kaminsky, S. and Podell, D.M. (1997). *Educational psychology: Windows on teaching*. New York: McGraw-Hill College.

Gronlund, N.E. (1977). *Constructing achievement test*. Englewood Cliffs, NJ: Prentice Hall.

Ebel, R.L. (1965). *Measuring educational achievement.* Englewood Cliffs, NJ: Prentice-Hall.

Haladyna, T.M. (1997). *Writing test items to evaluate higher order thinking*. Boston: Allyn and Bacon.

Hopkins, K.D., Stanley, J.C. and Hopkins, B.R. (1990). *Educational and psychological measurement and evaluation* (7theds.). Englewood Cliffs, NJ: Prentice-Hall.

Kauchak, D. and Eggen, P. D. (1998). *Learning and teaching: Research-based methods* (3rded.). Boston: Allyn and Bacon.

Lewis, A. and Smith, D. (1993). Defining higher order thinking. *Theory into Practice*, **32**(3) : 131-137.

McDavitt, D.S. (1993). *Teaching for understanding: Attaining higher order learning and increased achievement through experiential instruction* (ERIC Document Reproduction Service No. ED 374 093). Retrieved April 10, 2016 from http://www.cala.fsu.edu /files/ higher_order_thinking_skills.pdf.

McDade, S.A. (1995). Case study pedagogy to advance critical thinking. *Teaching of Psychology,* **22** (1) : 9-10.

Miri, B., David, B.C. and Uri, Z. (2007). Purposely teaching for

the promotion of higher-order thinking skills: A case of critical thinking. *Res. Sci. Edu.*, **37**(4) : 353-369.

Petress, K. (2006). Questions and answers: The substance of knowledge and relationship. *College Students J.,* **40**(2): 374-376.

Popham, W.J. (1975). *Educational evaluation.* Englewood Cliffs, NJ: Prentice-Hall.

Protheroe, N. (2007). What does good math instruction look like? *Principal,* **87**(1) : 51-54.

Resnick, L.B. (1987). *Education and learning to think*. Washignton, DC: National Academies Press.

Shaycoft, M.F. (1979). *Handbook of criterion referenced testing: Development, evaluation and use*. New York: Garland STPM-Press.

Stanley J.C. and Hopkins, K.D. (1972).*Educational and psychological measurement and evaluation*. Englewood Cliffs, NJ: Prentice-Hall.

Tomei, L. (2005). *Taxonomy for the technology domain*. London, NY: McGraw Hills.

Twycross, A. and Shields, L. (2004). Validity and reliability—what's it all about? Part 1 validity in quantitative studies: This is one of a series of short papers on aspects of research. *Paediatric Nursing,* **16**(9) : 28-29.

Zohar, A. and Dori, Y.J. (2003). Higher order thinking skills and low-achieving students: Are they mutually exclusive? *The J. Learning Sci.*, **12**(2) : 145-181.

****