International Journal of Educational Research and Studies
www.journalofeducation.net
Online ISSN: 2664-6811; Print ISSN: 2664-6803; Impact Factor: RJIF 5.46
Received: 03-01-2021, Accepted: 22-01-2021, Published: 25-03-2021
Volume 3, Issue 1, 2021, Page No. 20-22

Exploring levels of higher order thinking skills (HOTS) of senior secondary school students of mathematics

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Abstract
The paper provides an exploration of the level of Higher Order Thinking Skills (HOTS) of school students of grade XII studying Mathematics. Government school of Punjab School Education Board of Patiala district was selected randomly. It was planned to use Experimental approach of research. Verbal Intelligence test was applied on 123 students and Normal intelligent students were selected for the investigation. The investigator standardized a test on HOTS and applied to randomly Selected 80 normal intelligent students. The findings revealed that the level of HOTS of secondary school students of Mathematics is moderate. It is further suggested to apply diverse teaching techniques to enhance the level of HOTS.

Keywords: government school, investigator standardized a test on HOTS

Introduction

The concept of higher order thinking (HOT) is derived from the Bloom taxonomy of cognitive domain introduced in 1956 (Forehand, 2010) [8]. Bloom categorized intellectual behavior into six levels of thinking as knowledge, comprehension, application, analysis, synthesis and evaluation (Clark, 2010; Yahya *et al*., 2012) [6, 10]. The categories in the Bloom taxonomy are hierarchically organized from concrete to abstract. This progression identifies the lower level to higher level of cognitive processing. Based on research into the cognitive domain among secondary school students, the first three categories of the Bloom taxonomy, knowledge, comprehension and application measure the student's lower level of thinking skills (LOTS) whereas the other three levels of analysis, synthesis and evaluation measure the higher levels of thinking skills or HOTS (Chang & Mao, 1999) [5]. HOTS is intellectually disciplined process of actively conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered or generated by observation, experience, reflection, reasoning, or communication.

The definition of the term HOTS were provided by several specialists, it involves the transformation of information and ideas. This transformation occurs when students analyze, combine facts and ideas and synthesize, generalize, explain, or arrive at some conclusion or interpretation. Manipulating information and ideas through these processes make students to solve problems, gain understanding and discover new meaning (Tomei, 2005) [3].

From the above conceptual framing of HOTS the investigator concludes that HOTS are intellectual processes where students have to activate their minds in order to understand the meaning from the information introduced to them, draw relations among ideas, derive principles and rules, analyze and classify, generate and combine new ideas, evaluate and judge.

A major factor in the growth of higher order thinking is a student-centred classroom. It supports the open expression of ideas, provides active modelling of thinking processes, develops thinking skills, and motivates students to learn. Without it, students will not persist in higher level thinking processes. Team or group work facilitates knowledge construction through social interaction (Batton, Melissa 2010) [4].

Higher order thinking involves a variety of thinking processes applied to complex situations and have impact of multiple variables. Higher order thinking depends upon an individual's ability to apply, reorganize, and establish knowledge in the context of thinking situation. Procedural knowledge sometimes is misunderstood as a higher order thinking skill. Whereas it may be a pre requisite for higher order thinking, it actually, is a type of knowledge, specifically knowledge of rules and their application (Crowl *et al*., 1997) [2]. Critical thinking ability of secondary student showed remarkably difference between the cooperative learning approach group and traditional method group. Analysis showed that critical thinking ability of student of cooperative learning group was higher than the student of traditional method group. The cooperative learning approach was more effective than the traditional method in developing critical thinking ability of both boys and girls, among high, middle and low achievers (Deepa, 2012) [7].

Thus after reviewing existing information investigator urged to explore the level of Higher Order Thinking Skills of secondary school students of Mathematics.

Research Objective

Specific objective of the study would be to identify the level of higher order thinking skills of senior secondary school students of Mathematics

Hypotheses

Converting the objective in terms of hypotheses would emerge as probable to be tested for their statistical significance.

1. It is anticipated that the senior secondary students of Maths will have low order of thinking skills.

Research Tools

The following scales were used for testing:

1. Verbal Intelligence Test by R.K.OJHA and K.RAY CHOWDHURY for age group of 13 to 20 years was administered.

2. Higher Order Thinking Skills Scale developed and standardised by the investigator was administered to the sample of the study.

Method and Procedure

One of the school was selected randomly by drawing a lottery from the list of government senior secondary schools of Patiala district of Punjab. A sample of 123 students of +2 class was taken, intelligence test was administered and on the basis of results obtained 80 students with average intelligence was selected for investigation. Higher Order Thinking Skills (HOTS) Scale was administered on randomly selected average intelligent subjects. The results were interpreted as follow.

Data Analysis and Interpretation

For conducting this study Verbal Intelligence Test was applied on 123 senior secondary school students of mathematics of 10+2. To find out the type of distribution of data for level of intelligence, Mean, Median, Mode, S.D., Kurtosis and Skewness were computed and results have been presented in table 1.1.

Table 1: Frequency Distribution for Scores of Intelligence Test

N	123
Mean	79.78
Median	80.00
Mode	76.00
Standard deviation	1.1507
Kurtosis	0.067
Skewness	0.096

Table 1.1 shows that the mean of intelligence test is 79.78 with median of 80 and standard deviation of 1.1507. As the values of mean, median and mode are nearly the same, it is evident from frequency distribution that the distribution of data is normal. The value of kurtosis is 0.067 which is quite close to normal value of 0.263.

Further to find the levels of intelligence Q1 and Q3 were calculated. The value of Q1and Q3 is 73 and 86 respectively. It indicates that subjects having score more than 86 are more intelligent and subjects having score less than 73 are less intelligent whereas rest of the subjects lies in normal range of intelligence. It was found that 20.32% are less intelligent and 24.39 % are highly intelligent where as 55.29 % are found as lying on average level of intelligence.

Further to proceed for the investigation, the scores obtained were analyzed on the basis of Verbal Intelligence Test as shown in table 1.2

Table 2: Classification of Data on Level of Intelligence

Range of Raw Score	Classification	No. of subjects	Percentage
107 & above	Very superior	00	0
99 to 106	Superior	11	8.94%
91 to 98	Bright – normal	07	5.69%
73 to 90	Normal	80	65.04%
65 to 72	Dull- normal	15	12.20%
57 to 64	Borderline	06	4.88%
56 to below	Defectives	04	3.25%
Total		123	

8.94% subjects were found to be superior intelligent, 12.19% were dull normal, 4.87% were on borderline while 3.25% were found defective. Total of 87 subjects comprising 70.73% were found to be lying on the normal and bright normal range. Higher Order Thinking Skills (HOTS) scale, developed and standardized by the investigator was applied on the group of 80 subjects lying on the normal and bright normal range of intelligence. To find out the type of distribution of data Mean, Median, SD, Kurtosis and Skewness were computed and results have been presented in the table 1.3.

Table 3: Frequency Distribution for Scores of hots Scale

N	80
Mean	13.38
Median	14.00
Mode	16.00
Standard deviation	3.196
Kurtosis	-0.494
Skewness	-0.291
Q3	16
Q1	11

The result shows that the mean of HOTS scale is 13.38 with median of 14, Mode of 16 and standard deviation of 3.196. As the values of mean, median and mode are nearly the same, it is evident from frequency distribution that the distribution of data is normal. The value of kurtosis is -0.494 which is quite close to normal value of 0.263. Values of Q3 and Q1 of HOTS scale are 16 and 11 respectively. It is observed that the mean score of HOTS of senior secondary students of mathematics lies between 16 and 11 which indicate moderate level of HOTS among students of Mathematics.

Percentage were calculated for all three levels of HOTS of senior secondary school students of Mathematics and it has been found that 13.75% students of mathematics fall in the category of high HOTS whereas 57.50% fall in moderate level and remaining 28.75% lies in the category of low HOTS and the results have been presented in the pie chart of following figure.

The percentage for different Levels of HOTS

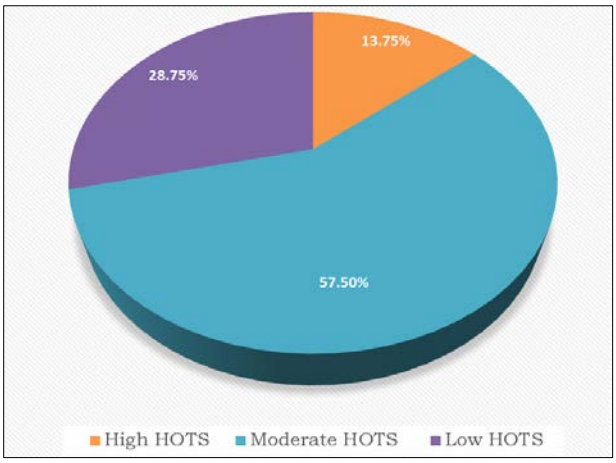

Fig 1

Conclusions and Implications

It can be interpreted that level of HOTS among senior secondary school students of Mathematics is moderate. Hence the findings of the study do not support the hypothesis which stated that senior

secondary school students of Mathematics will have low order of thinking skills.

A study conducted by Gulistan *et al.* (2015) [9] does not support the findings of the present study as it was revealed that the majority of students were at lower level of thinking skills. It is further found that more male students were at lower level than female students. However, there was no significant difference between student's level of higher order thinking skills and their gender. Based on the results of student's level of higher order thinking skills, the study provided evidence that almost all students needs to improve their higher order thinking skills especially the synthesis and evaluation skills required for improving student's creativity.

The possible reason for the finding of the present study may be that exposure to Mathematics and easy access of advanced technology, latest gadgets enhanced their level of Higher Order Thinking Skills. It further seeks the improvement in Higher Order Thinking Skills to move moderate to high level thinking skills by using appropriate teaching learning methods and technique.

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