



Cognitive Predictors Of Mathematics Performance Among Higher Secondary Students.

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ABSTRACT

A total of 600 Higher Secondary Students from various types of school of different gender have been taken for the study to measure relationship between Cognitive Abilities and Mathematics Performance of Higher Secondary Student in and around Chennai. Cognitive Abilities Test of Vishal Sood and Pooja Sharma (2018) were taken and the questionnaire was modified by the researcher to suit Higher Secondary Students. The result shows that, the overall relationship between Cognitive Abilities and Mathematics Performance correlates significantly and furthermore found that the performance of female students is comparatively lower than male students in Cognitive Abilities as well as in Mathematics Performance.

Keywords: Cognitive Predictors, Cognitive Abilities, Mathematics Performance, verbal ability, numerical ability, verbal reasoning ability, abstract reasoning ability, matrix, algebra, calculus and probability.

1. INTRODUCTION

Cognitive abilities are mental skills that are used in the process of experiencing the knowledge which is considered as the Cognitive Predictors of this study. It is the ability which is used to learn, understand, integrate information and apply in the necessary situation. There have been many sorts of cognitive abilities. According to Vishal and Pooja (2017) there are four major cognitive abilities viz., verbal ability, numerical ability, verbal reasoning ability and abstract reasoning ability.

Basic calculation skill was the significant predictor of mathematics problem solving reported by Decker and Roberts (2015). Additionally, only selected cognitive variables contributed to the prediction of math problem solving and also these variables change its vital role as children develop higher level mathematics performance. Mathematics has been regarded as an opportunity to understand real life. Hence in order to understand how higher secondary students' cognitive abilities contribute to their Mathematics Performance, the research has been conducted.

Cognitive ability affects age and gender, which are the main sources of individual differences in Mathematics Performance founded by Kiosseoglou et al. (1999). Genders from 13 to 15 years were taken for the study. Path analysis and ANOVA were used by the researcher, and the results obtained showed that cognitive ability directly influenced Mathematics Performance. The numeracy and literacy skills of 673 students were tested by Cheung et al. (2018) tried to find out whether family and individual variables were associated with children's numeracy using structural equation modelling analyses which shows that students numeracy competence was related to their gender, age and socio – economic status. Differences in general cognitive ability cause differences in mathematical attainment, as detected by Cowan et al (2020) on a sample of 948 students aged 7, 9 and 10 years.

2. METHODOLOGY

2.1 OBJECTIVES

Using the review of literature and the theoretical aspects the objectives were framed

- To ascertain the relationship between Cognitive Abilities and Mathematics Performance.
- To find out the difference between Male and Female of Higher Secondary Students with respect to their Cognitive Abilities and Mathematics Performance.
- To find out the difference among Higher Secondary Students studying in different types of schools with respect to their Cognitive Abilities and Mathematics Performance.

2.2 SAMPLE

From three different types of schools namely Government, Government-Aided and Private a sample of 600 Higher Secondary Students was taken for the study using random sampling techniques in and around Chennai.

2.3 PROCEDURE AND MATERIALS

Cognitive Abilities: Vishal Sood and Pooja Sharma (2018) constructed the tool for cognitive ability for the age group of 12 to 14 years which has been taken by the researcher (T. Anitha (2019)) and modified the same with the help of the research supervisor of Higher Secondary Students, which contains 76 items of multiple choice with four options with one correct answer and the remaining three as wrong answers. For each correct answer one mark was awarded and for wrong answers, no marks. The items were classified into four factors in which verbal ability contains 33 items, numerical ability has 13 items, abstract reasoning ability has 13 items and the last, verbal reasoning ability has 17 items.

Mathematics Performance: Based on Tamil Nadu syllabus, the researcher (T. Anitha (2019)) developed the tool for Mathematics Performance variable for the higher secondary students which contains four classifications. Those are matrix, algebra, calculus and probability, keeping in mind the weightage of the chapter for their higher level of education. It contains 60 items of multiple-choice questions with four options and among them, correct answer was awarded one mark and no marks for the wrong answer.

2. STATISTICAL ANALYSIS

Hypothesis 1: There is significant relationship between Cognitive Abilities and Mathematics Performance.

Table 3.1 Correlation showing the relationship among dimensions of Cognitive Abilities and Mathematics Performance.

COGNITIVE ABILITIES	MATRIX	CALCULUS	PROBABILITY	ALGEBRA	OVERALL MATHEMATICS PERFORMANCE
VERBAL ABILITY	.122**	.137*	.310*	.360**	.368**
NUMERICAL ABILITY	.233**	.206**	.073	.049	.246**
ABSTRACT REASONING ABILITY	.311*	.179*	.092*	.085*	.283**
VERBAL REASONING ABILITY	.296*	.054	.075	.102*	.212**
OVERALL COGNITIVE ABILITIES	.362**	.223**	.261**	.291**	.466**

Note: * denotes Significance at 5% level. ** denotes significance at 1% level.

To find the relationship between the variables, Cognitive Abilities and Mathematics Performance Pearson Correlation Coefficient was used. From the above table it is inferred that in the overall relationship between Cognitive Abilities and Mathematics Performance correlates significantly at 1% level of significance. The dimension Matrix in Mathematics Performance is related to all the dimensions of Cognitive Abilities. The dimension Calculus in Mathematics Performance is related to all the dimensions of Cognitive abilities except verbal reasoning ability. The dimension Probability in Mathematics Performance correlates significantly to all the dimensions of Cognitive Abilities except numerical and verbal reasoning ability. And also, the dimension Algebra in Mathematics Performance correlates significantly to all the dimensions of Cognitive Abilities except numerical ability.

Hypothesis2: There is no significant difference between Male and Female Higher Secondary Students with respect to their Cognitive Abilities and Mathematics Performance.

Table 3.2 t – test showing the difference between Male and Female Students in their Cognitive Abilities and Mathematics Performance.

GENDER	MALE		FEMALE		t value	Level of significance
	MEAN	SD	MEAN	SD		
DIMENSIONS OF COGNITIVE ABILITIES						
VERBAL ABILITY	21.43	5.80	21.48	4.130	0.119	NS
NUMERICAL ABILITY	8.62	2.395	7.95	2.807	3.145	0.01
ABSTRACT REASONING ABILITY	8.97	2.493	7.96	2.813	4.654	0.01
VERBAL REASONING ABILITY	10.79	3.241	10.78	3.339	0.037	NS
OVERALL COGNITIVE ABILITIES	49.81	8.819	48.16	7.718	2.429	0.05
DIMENSIONS OF MATHEMATICS PERFORMANCE						
MATRIX	7.72	2.565	7.54	2.871	0.810	NS
CALCULUS	15.62	3.687	15.22	3.721	1.323	NS
PROBABILITY	8.35	2.010	7.89	2.399	2.545	0.05
ALGEBRA	7.83	2.583	7.41	3.012	1.833	NS
OVERALL MATHEMATICS PERFORMANCE	39.51	6.600	38.05	7.122	2.604	0.01

Note: NS – Non-Significant

From the table, it is inferred that the male and female students differ significantly with respect to overall Cognitive Abilities and its dimensions such as numerical (3.145) and abstract reasoning ability (4.654), except verbal ability (0.119) and verbal reasoning ability (0.037). The mean value of overall Cognitive Abilities for the male students (49.81) is greater than the female students (48.16). Due to less exposure, female students may have fewer Cognitive Abilities when compared with male students. This should be taken into serious consideration. Even though we are in the constantly evolving era, the female students have fewer thinking abilities than male students especially in numerical ability and abstract reasoning ability. Since the P value is less than 0.05 level, the hypothesis that neither gender differs significantly in Cognitive Abilities of Higher Secondary Students is rejected at 5% level of significance.

From the table it is inferred that the male and female students differ significantly with respect to overall Mathematics Performance. The male and female students do not differ significantly with respect to the dimensions of Mathematics Performance such as matrix (0.810), calculus (1.323) and algebra (1.833), except probability (2.545). The mean value of overall Mathematics Performance is higher for the male students (39.51) than the female students (38.05). On comparing the mean values, the male students have strong knowledge of basic arithmetics as well as content knowledge of matrix, algebra, calculus and probability of higher secondary mathematics than the female students. Since the P value is less than 0.01 level, the hypothesis that neither gender differs significantly of higher secondary students with respect to Mathematics Performance is rejected at 1% level of significance.

Hypothesis 3: There is no significant difference among the Higher Secondary Students studying in different Type of Schools with respect to their Cognitive Abilities and Mathematics Performance.

Table3.3 One -way Analysis of Variance showing the mean difference in Cognitive Abilities and Mathematics Performance of students studying in different Type of Schools.

TYPE OF SCHOOLS	GOVT.	GOVT.AIDED	PRIVATE	F ratio	P value	Level of Significance
DIMENSIONS OF COGNITIVE ABILITIES						
VERBAL ABILITY	21.43 ^a (5.973)	21.55 ^a (4.076)	21.38 ^a (4.100)	.070	0.933	NS
NUMERICAL ABILITY	8.18 ^{ab} (2.703)	8.68 ^b (2.359)	8.01 ^a (2.769)	3.519	0.030	0.05
ABSTRACT REASONING ABILITY	7.87 ^a (2.803)	8.48 ^b (2.595)	9.04 ^c (2.590)	9.749	0.000	0.01
VERBAL REASONING ABILITY	10.82 ^{ab} (3.673)	11.14 ^b (2.830)	10.40 ^a (3.279)	2.546	0.079	NS
OVERALL COGNITIVE ABILITIES	48.29^a (10828)	49.84^a (6.291)	48.83^a (7.090)	1.800	0.166	NS
DIMENSIONS OF MATHEMATICS PERFORMANCE						
MATRIX	7.44 ^a (2.835)	8.27 ^b (2.463)	7.19 ^a (2.747)	8.754	0.000	0.01
CALCULUS	15.01 ^a (3.659)	15.16 ^a (4.193)	16.07 ^b (3.122)	4.909	0.008	0.01
PROBABILITY	7.76 ^a (2.346)	8.22 ^b (2.089)	8.38 ^b (2.190)	4.356	0.013	0.05
ALGEBRA	7.66 ^a (2.929)	7.47 ^a (2.944)	7.72 ^a (2.554)	.419	0.658	NS
OVERALL MATHEMATICS PERFORMANCE	37.86^a (8.158)	39.12^{ab} (6.434)	39.37^b (5.831)	2.800	0.062	NS

Note:1) NS – Non-significant

2) The value within the bracket refers to SD.

Based on Duncan Multiple range test, it deduced that there is no significant difference among the higher secondary students with respect to Type of Schools in verbal ability, verbal reasoning ability, Overall Cognitive Abilities, algebra and Overall Mathematics Performance. Hence the P value is lesser than 0.05 level, the hypothesis is rejected. But there is significant difference in numerical ability and probability at 5% level of significance in which govt-aided and private schools are significantly different based on the factor of numerical ability, govt and govt-aided, as well as govt and private differs significantly with respect to probability.

From the table it is also inferred that, there is significant difference among abstract reasoning ability, matrix and calculus at 1% level of significance with respect to type of schools. Hence the hypotheses are rejected with regard to abstract reasoning ability, matrix and calculus. From the table it is also inferred that, there is significant difference between govt. and govt-aided, govt. and private, private and govt-aided with regard to abstract reasoning ability, govt. and govt-aided, govt-aided and private differs significantly with regard to matrix, private and govt, private and govt.-aided differs significantly with regards to calculus.

4. RESULTS

It is inferred that Cognitive abilities and mathematics performance are correlated. But some of the factors of Cognitive abilities and Mathematics performance are not related. Namely the factor, verbal reasoning ability is not related with the factor calculus of mathematics performance, factors of cognitive abilities such as numerical ability and verbal reasoning ability are not related to the factor probability of mathematics performance, finally factor numerical ability of cognitive abilities is not related to the factor algebra of mathematics performance.

It is also deduced that male and female students of the higher secondary differ significantly with respect to overall Cognitive Abilities and overall Mathematics Performance at 5% and 1% level of significance respectively. The result shows that there is no significant difference among the higher secondary students with respect to Type of Schools in Overall Cognitive Ability and Mathematics Performance identified using Duncan Multiple Range Test (DMRT).

3. DISCUSSION

The research was conducted for the benefit of students and teachers to improve their mathematics performance and also to help teachers, to find the students ineffectiveness towards certain abilities respectively. Kiosseoglou et al. (1999) found that Cognitive ability, affects age and gender which are the main sources of individual differences on mathematics performance. According to the research result the male and female students differ significantly in cognitive abilities especially in the dimensions of numerical ability and abstract reasoning ability. So, the teachers have to focus on these two abilities for the female students to eliminate the difference between either gender. And also, the male and female students differ significantly in Mathematics performance in the specific dimension of probability. Even though the factor probability has been taught to the students from 13 years, girls are not convinced of the particular dimension. Hence, the teachers have to discuss on this specific topic with the girls to ensure equal education among the children.

Even though there is no significant difference in overall mathematics performance and cognitive abilities, some specific domains such as, Numerical ability, abstract reasoning ability, matrix, calculus and probability differs significantly based on their type of schools. The result found is not a healthy one. Hence the officials in education department should focus on all the schools by regularly conducting inspections about students' performance and also should conduct workshop, orientation programmes, debates, quiz programmes among various schools and within schools in order to develop their abilities and to share their knowledge with others.

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