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In-depth Study of Cognitive Abilities Among 'High Achievers' and 'Low Performers' in School Academics

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Abstract
The present research project was undertaken to get an in-depth insight into the cognitive abilities of children and the impact of these abilities on their academic performance. Efforts were made to analyze and compare the Intelligence Quotient, Focus Factor, Decision Making Ability, Creative Quotient and the academic performance of the students. The research was conducted in Chandigarh and Mohali. Purposive sampling was followed to select students. The sample consisted of two groups, boys as well as girls, of 11th standard, and their result and assessment of the previous year i.e. 10th standard was considered. The first group-Group A included 'low performers' scoring marks between 45% and 55%. The second group-Group B included 'High Achievers' having scored above 85% marks. Post analysis, the cognitive abilities of Group B were found to be higher whereas in case of Group A, at least one of the said cognitive abilities was below par,through which it is deduced that Intelligence Quotient, Focus Factor, Decision Making Ability as well as Creative Quotient are equally important for getting success in academics.

Keywords
Cognitive Abilities, Academic Performance, Intelligence Quotient, Focus Factor, Decision Making Ability, Creative Quotient

Introduction

The fundamental goal of education is to equip students with the knowledge and skills necessary to think critically, solve complex problems, and succeed in the 21st century society and economy. Measurement of such knowledge and skills is essential for tracking students' development and assessing the effectiveness of educational policies and practices. Education and psychological science have examined these issues in nearly complete separation. Education researchers have used many measures of learning, but recent research has been drawn primarily on standardized achievement tests designed to assess students' mastery of state-defined content standards in core academic subjects (Borman, Hewes, Overman, & Brown, 2003; Hanushek&Rivkin, 2010). Psychological science has used measures of several cognitive concepts to assess variation in domain-independent mental skills, including processing speed (how efficiently information can be processed (Kail&Salthouse, 1994)), working memory capacity (how much information can be simultaneously processed and maintained in mind (Cowan, 2005; Gathercole, Pickering, Knight, &Stegmann, 2004)), and fluid reasoning (how well novel problems can be solved; (Engle, Tuholski, Laughlin, & Conway, 1999)). The present study integrated these two approaches to measuring knowledge and skills by asking how the enhancement of academic performance by schools relates to the types of cognitive skills studied in psychological science.Studies of cognitive development have focused on processing speed (PS), working memory (WM) capacity, and fluid reasoning (FR) as three inter-related cognitive abilities that develop markedly from childhood through adulthood and that predict individual differences in performance on numerous measures (Cowan et al., 2005). Studies from late childhood through young adulthood indicate that gains in PS support gains in WM capacity that, in turn, support FR (Coyle, Pillow, Snyder, &Kochunov, 2011; Fry & Hale, 1996; Kail, 2007). Cognition is the entire thinking process primarily including Intelligence Quotient, Focus Factor, Decision Making Ability, Creative Quotient, EQ, Memory, Reasoning, Gifted Intelligences & Natural Abilities. Success requires a focused mind, strong & quick decision making ability, creativity & early grooming on natural abilities. Merely having a high IQ or being academically intelligent does not lead us to a successful career. The fact is that there are other cognitive factors that play a prominent role in our life. For over 100 years, researchers are working hard to find out a universal mechanism that can help educators/parents/schools, to drastically enhance the learning process in children, a mechanism that can create natural interest of every child in academics, a delivery standard that can elevate the cognitive process, a matrix that can define human cognition so that it can be reordered as desired. The outcome of a successful career should include personal fulfillment, work/life balance, goal achievement and financial assurance. Career Management is an art, which must be learnt before launching ourselves into the dynamism of life. It is the combination of structured planning and choices. Research & analysis reveal that what works for one individual may not work for other in terms of success despite having same qualification and career choice. Cognitive Neuroscience Technology is the Future of Education. Groundbreaking cognitive neuroscience research has occurred over the last 20 years, without parallel growth of consumer awareness and appropriate professional dissemination. "Cognition" remains an elusive concept with unclear implications outside the research community. The theory of success, theory of multiple intelligences and the theory of brain development will play a significant role in shaping the future of education for the next 100 years.These maturing mental abilities are thought to broadly underpin learning and cognitive skills. Variation in these measures predicts performance on a wide range of tasks among adults, including comprehension (Daneman& Carpenter, 1980), following directions, vocabulary learning, problem solving, and note-taking (Engle, Kane, &Tuholski, 1999). Critically, these cognitive abilities are associated with academic performance. Executive function measured in preschool predicts performance on math and literacy in kindergarten (Blair &Razza, 2007), and parental reports of attention span-persistence in 4 year-olds predicts college completion at age 25 (McClelland, Acock, Piccinin, Rhea, & Stallings, 2013). Likewise, WM skill correlates with math and reading ability among 5- and 6-year olds (Alloway&Alloway, 2010) and among 11- and 12-year olds (St Clair-Thompson &Gathercole, 2006), and predicts mathematics and science achievement among adolescents (Gathercole et al., 2004). Thus, cognitive skills appear to promote or constrain learning in school. Although cognitive skills are seldom taught explicitly in schools,

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research indicates that schooling can promote cognitive skills in children. Using age cut-offs that determine the age young children are enrolled in schools, studies have shown that attending (versus not attending) school for a year (Burrage et al., 2008) or attending school for more years (McCrea, Mueller, &Parrila, 1999) was associated with better performance on tests of working memory and executive functions. Reviews of the empirical literature examining the relationship between schooling attainment and IQ reveal a consistent positive relationship between time spent in school and measures of intelligence (Ceci, 1991; Ceci& Williams, 1997). These observational studies suggest that school attendance can improve cognitive skills beyond what is taught directly. What is unknown, and crucial for informing educational policy, is whether general educational practices that increase academic performance also have a positive impact on basic cognitive skills. Schools traditionally focus on teaching knowledge and skills in content areas, such as mathematics and language arts. Use of such knowledge can be referred to as crystallized intelligence (Cattell, 1967). In contrast, fluid intelligence refers to the ability to solve novel problems independent of acquired knowledge; the cognitive measures in the present study are indices of fluid intelligence. Do schools where students are experiencing high levels of academic success in crystallized intelligence achieve this success by promoting the growth of fluid cognitive abilities? The strong relation between cognitive ability and academic performance suggests that schools that are particularly effective in improving academic performance may also improve domain-independent cognitive skills. To shed light on this issue, we examined the relations between scores on standardized tests in mathematics (Math) and English language arts (ELA) on the Massachusetts Comprehensive Assessment System (MCAS) and measures of cognitive skills among 1,367 8th graders attending traditional district, (test-in) exam, and charter public schools in a large urban school district. First, we asked whether there was an association between 8th-grade MCAS scores, gains in MCAS scores between 4th and 8th grade, and cognitive skills. Second, we compared the share of the overall variance in MCAS scores and cognitive skills explained by the school attended in 8th grade. Finally, we asked whether attending one of five over-subscribed charter schools that select students randomly by lottery and that generate consistent achievement gains on the MCAS (Abdulkadiroglu, Angrist, Dynarski, Kane, &Pathak, 2009; Angrist, Cohodes, Dynarski, Pathak, & Walters, 2013) also led to similar gains in cognitive skills.Kaur (1992) studied the interrelationship between creativity, intelligence and academic achievement of 11th grade boys and found that relationship between creativity and intelligence was low but positive; academic achievement commonly influenced the correlation between creativity and intelligence; relationship between creativity and intelligence was non linear; low positive relationship existed between creativity and academic achievement; creativity commonly influenced the correlation between academic achievement and intelligence; the relationship between intelligence and academic achievement was linear. Mishra (1997) examined the correlates of academic achievement of high school students and found that intelligence was significantly correlated with academic achievement for both boys and girls; the correlation between intelligence and academic achievement was higher in case of girls; socio economic status was not significantly related with academic achievement of boys and girls; academic achievement of rural students was lower than the achievement of urban students; academic performance of girls was superior to the performance of boys. Panda (1997) studied the impact of creativity and adjustment on academic achievement and found that creativity and adjustment were essential factors for the progress of academic achievement of student. The correlation between academic achievement and creativity, academic achievement and adjustment showed that there was a linkage between them. Therefore proper stress may be given to develop creative power among the students, so that they can be balanced and ultimately secure better academic achievement. Developing effective decision-making skills is one of the goals of guidance and counselling. The processes involved are efficient evaluation of problems, list of possible solutions in term of merits and demerits, application of the most appropriate solution, acceptance of the outcomes and acting upon the outcomes. Nirmala et al. (2006) studied optimization of academic achievement in mathematics with the objective to study the contributing factors and optimizing variables of academic achievement in Mathematics by taking a sample of 900 students from higher secondary classes and found that mathematics information processing skill, decision making skill and attitude towards mathematics had a significant contribution towards the academic achievement in mathematics; among the five factors of information processing skill two of them (surface disintegrated and strategic study) had played a significant role in getting maximum aggregate marks in mathematics; as regard the decision making, all the five factors (approach, internal, external, avoidance and quick) had played a prominent role in maximizing the aggregate performance in mathematics. Paltasingh (2008) studied relationship among creativity, intelligence and achievement scores of secondary school students with the objective to study the correlation between creativity and intelligence; intelligence and science achievement; intelligence and scholastic achievement by taking a sample of 180 subjects of IX class from Oriya medium secondary school and found that there was significant positive correlation among creativity and science achievement, creativity and scholastic achievement, intelligence and science achievement as well as intelligence and scholastic achievement. Kardesh et al. (1988) studied effect of cognitive style and immediate testing on learning from lecture with the objective to investigate the relationship between cognitive style and problem solving ability of 400 eighth grade males and females and found that problem solving was positively correlated to cognitive style and concluded that field independent subjects were more proficient problem solvers than field dependent subjects; performance after immediate testing was in favour of male field independent students. Sheikh (1990) studied cognitive style in relation to intelligence, creativity and academic achievement of 185 adolescents of government school. The results indicated that high intelligent and high creative group tend to be more field independent than average and low intelligent and creative group. Average intelligent groups were more field independent than low intelligent group but high and average creative group do not show any significant difference in the cognitive style; female students had greater field independence than their counterpart male adolescent. Cattell et al. (1968) attempted to predict school achievement and creativity from ability, personality and motivation measures and reported that the primary source traits of conscientiousness (G), submissive (E), friendship (A) and dependability (Q) were related to achievement. Bachtold (1969) studied the personality characteristic of 227 over and under-achiever bright 5th grade students' with the help of children's personality questionnaire and found that successful female

achievers got higher scores on credibility, self confidence and self control compared to under achievers; successful male achievers scored higher on emotional stability, seriousness and sensitivity in comparison to under achievers. Roy (1992) studied personality differentials of adolescents with scientific creativity in relation to environment with the objective to study personality differences between low and high scientifically creative adolescents in terms of Cattell's trait theory and found that typical high scientific creative adolescent were more resolved, critical, more abstract thinker, more stable emotionally, more excitable, more independent, serious and prudent, more expedient, more venturesome, more tough minded, more individualistic, more self assured, self sufficient, self disciplined and more relaxed than low scientific creative adolescents. Suresh et al. (1998) studied achievement motivation and decision making styles among university students and found that achievement motivation was positively related to vigilant decisions. In tenth grade, three factors of 'high school personality questionnaire' viz. intelligence, conscientiousness and self sufficiency were positively related to achievement. Kumari (2005) studied the relationship between creativity, intelligence, adjustment and value patterns among adolescents by taking a sample of 545 students of senior secondary classes selected through stratified random sampling technique and found that level of adjustment was significantly related to the amount of intelligence; level of adjustment increased during adolescence stage. Creativity is the ability to make or bring to existence something new, whether a new solution to a problem, a new method or device or a new artistic object or form. Penick (1992) described creativity as a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements and disharmonies as well as identifying, searching for solutions, making guesses or formulation of hypotheses, and possibly modifying and restating them, and experimenting to find results and finally communicating the results. Nwazuoke, Olatoye and Oyundoyin (2002) argued that environment where a child finds himself/herself could foster or inhibit creativity. Though a child may have the innate or genetic ability for creativity, yet parents and teachers have roles to play to enhance and foster the creative traits. Dingledine (2003) asserted that family support, availability of learning materials and social pressures are some of the factors that influence the development of creativity. From these findings, it is clear that if teaching, assessment and social environment do not support creative thinking, the innate tendency in learners to be creative may be subdued. Creativity is fundamental to self-reliance, the more self-reliant a person becomes, the better the quality of his/her life, family, community and society at large. Creativity enables human beings to get the most out of life experiences and resources. Creativity produces actionable ideas, new concepts, new designs and new opportunities while innovation adds values to the new products. According to Akinboye (2003), without creativity, a person is not able to access the fullness of information and resources available but is locked up in old habits, structures, patterns, concepts and perceptions. This is why creativity, generative perception, constructive and design thinking plus innovation should form the basis of any education for sustainable development. Creativity is the confluence of intellectual activity, knowledge, motivation, thinking styles, personality and environment. Creativity should be related to intellectual activity and knowledge. The problem with our educational system is that students are not taught in a way that enhances creative thinking and the assessment procedures do not reward creativity. This is a serious challenge to our educational system especially the polytechnic education that should encourage exposure to technical skills which can be enhanced through creative thinking. Creativity is a basic tool for progress in any society or community. It is so important that any area of development must not lose sight of it. The conditions of modern day living characterized by complexity and interdependence, technological and communication advances, as well as rising expectations call for increased creativity (Olatoye&Oyundoyin, 2007). As the society becomes more complex, there is a gradual increase in the awareness that yesterday's methods do not effectively solve contemporary problems of the society (Akinboye, 1985). This is why innovation and creativity are needed in nearly all the facets of the society.

Method

The research was conducted in Chandigarh and Mohali. The sample consisted of two groups, boys as well as girls, of 11th standard, and their result and assessment of the previous year i.e. 10th standard was considered. The first group- Group A included 'low performers' scoring marks between 45% and 55%. The second group-Group B included 'High Achievers' having scored above 85% marks.The tool used was Cognitive Ability Test and Assessment. This test helps to numerically measure cognitive ability factors (Focus, Decision Making Ability, Creativity, Dynamic IQ) termed as natural ingredients for success in life in general. The data collected was analysed as per the set methodology. Both the groups were compared in terms of Percentage (signifying academic performance), Intelligence Quotient, Focus Factor, Decision Making Ability and Creative Quotient.

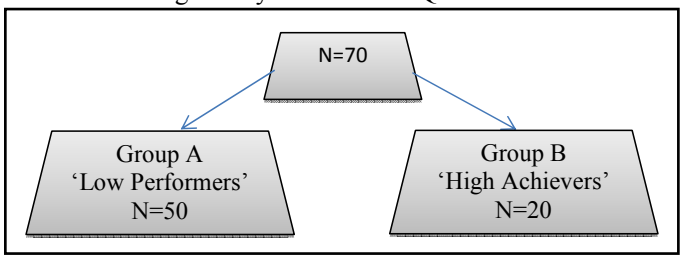

Fig.1 Sampling Procedure

Statistical Analysis

Once the data was obtained, it was coded, tabulated and analyzed, keeping in mind the objectives of the study. Appropriate statistical tools were used to draw meaningful inferences. The statistical tools used in the present study are given in the table below;

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Table 1 : Statistical tools used for analysis of data

S.No.	Statistical tools	Formula	Purpose
1.	Mean (x)	X = ΣX/N where, X = Variable N = No. of sample	To find out the average scores of variable used in the study.
2	Standard Deviation (S.D.)	$\overline{0} = \checkmark\Sigma$ x / N Where X = Deviation from actual mean X = mean. X = variable. N = number of samples.	To find out deviation from the mean scores of the variables.
3.	Standard error of mean (S.E)	S.E = 0/n Where 0 = S.D. n= number of observations	To find out the degree to which the mean is affected by the error of measurement and sampling.
4.	't' test	t = (x1-x2) / S $\overline{\checkmark n1n2}$/n1 + n2 where x1 = mean of 1st sample x2 = mean of second sample S = combine S.D. n1 = number of observations in 1st sample. n2 = number of observations in 2nd sample	To compare the average score of any two groups or to find out whether the mean of the two samples vary significantly from each other.

Results and Discussion

Table 2 : Distribution of IQ, FF, DMA, CQ & Marks of Group A and Group B

	Group An=50 Distribution of IQ, FF, DMA, CQ & Marks						Group B n=20 Distribution of IQ, FF, DMA, CQ & Marks				
S No	IQ	FF	DMA	CQ	MARKS (%)	S No	IQ	FF	DMA	CQ	MARKS(%)
1	97	35	0.65	0.35	54.25	1	93	145	0.32	0.95	94
2	102	45	0.54	0.45	53	2	99	120	0.53	0.84	88.5
3	99	36	0.59	0.4	54	3	112	102	0.67	0.65	91
4	116	65	0.39	0.63	51	4	115	75	1	0.63	90
5	99	70	0.39	0.64	51	5	116	75	1	0.52	93
6	95	30	0.74	0.25	54.5	6	126	65	1.6	0.36	85
7	95	30	0.74	0.25	54.5	7	120	65	1.26	0.45	82.25
8	97	35	0.65	0.3	54.5	8	113	95	0.9	0.64	90.5
9	106	45	0.51	0.5	53	9	105	106	0.6	0.75	92
10	106	45	0.51	0.5	53	10	110	105	0.64	0.65	92.5
11	110	45	0.51	0.52	53	11	102	106	0.56	0.75	88
12	99	39	0.58	0.4	53	12	112	102	0.83	0.64	88
13	102	39	0.54	0.43	53	13	118	70	1.1	0.5	87
14	92	65	0.42	0.6	52	14	106	105	0.64	0.72	87
15	90	65	0.42	0.6	52	15	95	130	0.39	0.9	87
16	115	65	0.4	0.6	51	16	114	95	0.91	0.63	86.25
17	97	35	0.61	0.35	54.25	17	97	122	0.5	0.86	93
18	97	35	0.61	0.36	54.25	18	117	75	1.06	0.52	93
19	94	30	0.84	0.21	54.5	19	124	65	1.3	0.43	85.5
20	94	30	0.8	0.21	54.5	20	94	135	0.34	0.95	94
21	94	30	0.8	0.25	54.5						
22	126	105	0.31	0.95	42						
23	126	106	0.31	0.95	40						
24	79	75	0.34	0.75	46						
25	101	95	0.34	0.75	46						

26	105	45	0.54	0.45	53	
27	83	45	0.54	0.45	53	
28	112	55	0.43	0.6	52	
29	113	55	0.43	0.6	52	
30	104	75	0.37	0.65	51	
31	117	75	0.37	0.65	47	
32	105	102	0.33	0.86	46	
33	93	45	0.44	0.52	53	
34	112	55	0.44	0.6	53	
35	124	105	0.33	0.9	42	
36	93	29	1.16	0.2	54.5	
37	93	29	1.16	0.2	54.5	
38	94	29	0.84	0.2	54.5	
39	99	95	0.34	0.84	46	
40	118	75	0.34	0.72	46	
41	95	30	0.74	0.25	54.5	
42	95	30	0.74	0.25	54.5	
43	118	75	0.37	0.65	46	
44	97	35	0.65	0.35	54.5	
45	97	35	0.65	0.35	54.25	
46	106	45	0.51	0.5	53	
47	99	36	0.58	0.4	54	
48	99	36	0.58	0.4	53	
49	99	35	0.59	0.4	54	
50	117	70	0.37	0.64	51	

Table 3: Difference in the Mean, Standard deviation, standard error, t-value and level of Significance in terms of Percentage

	N	MEAN	S.D.	S.E.M	t - value	P-value	Lev. of sig.
Group A	50	51.58	3.7437	0.5242	39.2419	<0.0001	Extremely Statically Significant
Group B	20	89.375	3.3975	0.7597			

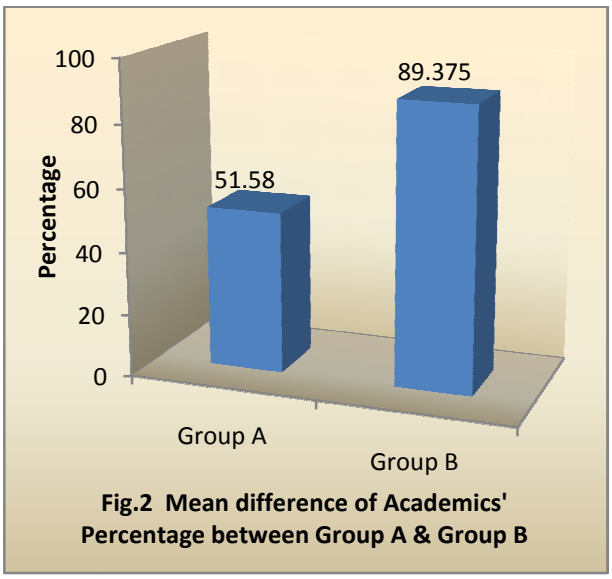

Fig.2 Mean difference of Academics' Percentage between Group A & Group B

As the purposive selection was followed to select the subjects for both the groups, there was found a significant difference between Group A and Group B in terms of their academic performance.

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Table4: Difference in the Mean, Standard deviation, standard error, t-value and level of Significance in terms of IQ

	N	MEAN	S.D.	S.E.M	t - value	P-value	Lev. of sig.
Group A	50	102.3	10.62	1.49	2.4741	0.0158	Statically Significant
Group B	20	109.4	10.04	2.25			

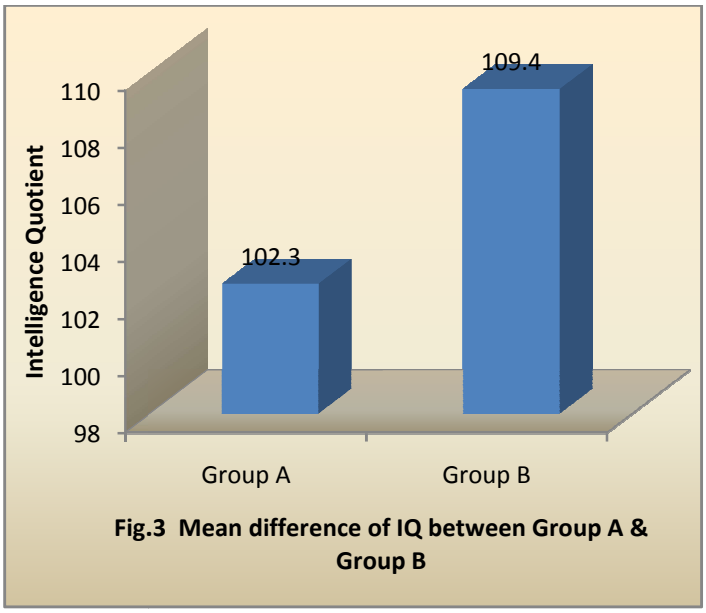

Fig.3 Mean difference of IQ between Group A & Group B

It was notified that there was a significant difference between Group A and Group B in terms of their Intelligence Quotient. The subjects of Group A were found to have quite low IQ as compared to those of Group B.

Table 5: Difference in the Mean, Standard deviation, standard error, t-value and level of Significance in terms of FF

	N	MEAN	S.D.	S.E.M	t - value	P-value	Lev. of sig.
Group A	50	52.72	23.39	3.27	8.6344	<0.0001	Extremely Statically Significant
Group B	20	97.9	24.68	5.52			

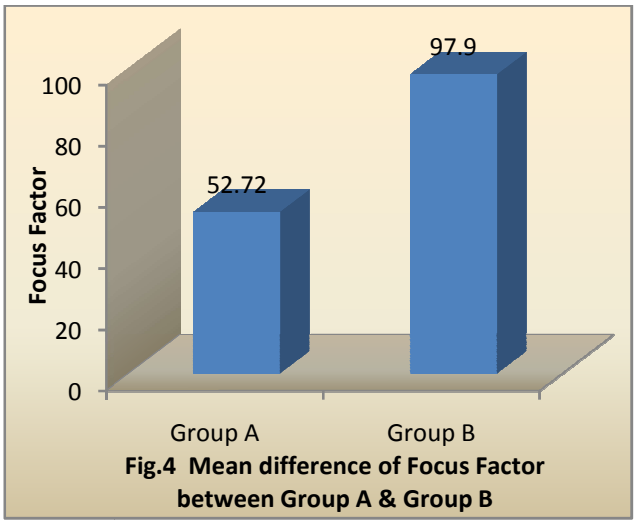

Fig.4 Mean difference of Focus Factor between Group A & Group B

A dramatic difference was noticed in the Focus factor between Group A and Group B. The subjects of Group B were found to have significantly high FF as compared to those of Group A, which was positively correlated to their academic performance.

Table:6 Difference in the Mean, Standard deviation, standard error, t-value and level of Significance in terms of DMA

	N	MEAN	S.D.	S.E.M	t - value	P-value	Lev. of sig.
Group A	50	0.5476	0.197	0.0276	3.1137	0.0057	Statically Very Significant
Group B	20	0.8075	0.3479	0.0778			

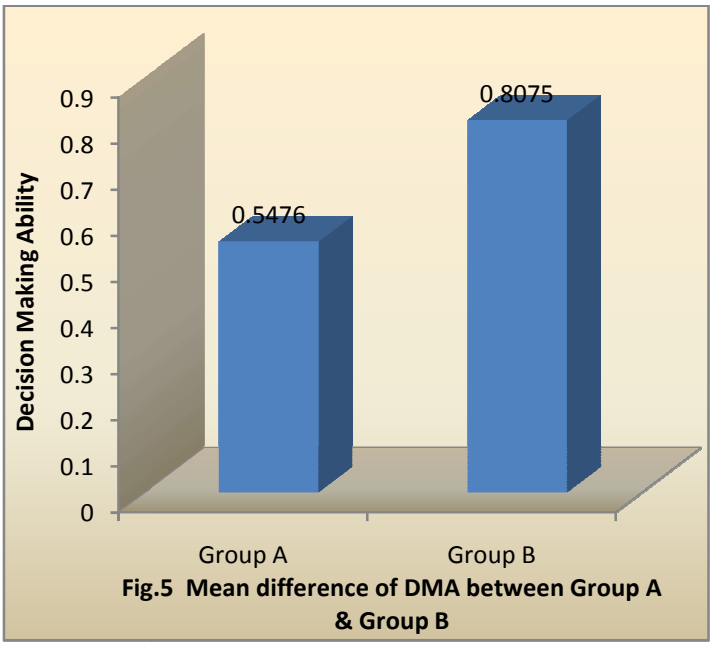

Fig.5 Mean difference of DMA between Group A & Group B

It is evident that the subjects of Group B had much better Decision Making Ability than those of Group A.

Table7 : Difference in the Mean, Standard deviation, standard error, t-value and level of Significance in terms of CQ

	N	MEAN	S.D.	S.E.M	t - value	P-value	Lev. of sig.
Group A	50	0.4966	0.2072	0.029	5.2299	<0.0001	Extremely Statically Significant
Group B	20	0.667	0.1735	0.0388			

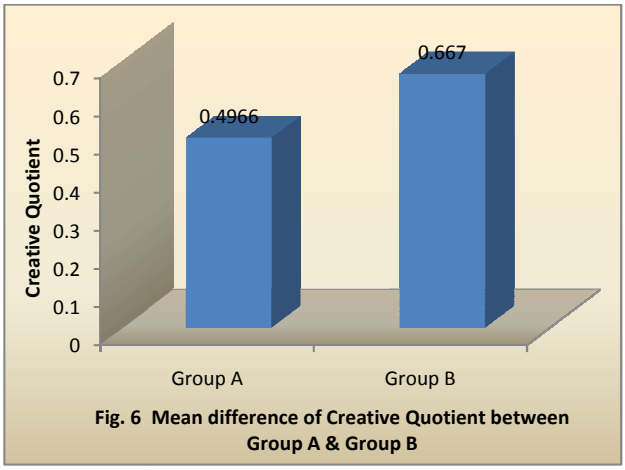

Fig. 6 Mean difference of Creative Quotient between Group A & Group B

It was witnessed that the creative quotient of Group B was much higher than that of Group A.

Conclusion

In conclusion, it can be defined that the academic performance of the students is directly proportional and is evidently positively correlated to their Cognitive abilities. It was witnessed that the cognitive abilities of Group B were significantly higher whereas in case of Group A at least one of the said cognitive abilities was below the desired value. Hence, it can be concluded that Intelligence Quotient, Focus Factor, Decision Making Ability as well as Creative Quotient are equally important for achieving success in academics.

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