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INTELLIGENCE AS A DETERMINANT OF ACADEMIC ACHIEVEMENT: A COMPARATIVE STUDY OF HIGH ACHIEVERS AND UNDERACHIEVERS

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ABSTRACT

A measure of the fluid intelligence, involving normative data standardization of Raven's Progressive Standard Matrices in Pakistani norms in international context is used which has enabled the role of fluid intelligence in academic achievement in the adolescent to be examined. The present study aimed to explore the role of fluid intelligence in academic achievement of adolescents with specific interest in difference of fluid intelligence between high achievers and underachievers. Data was drawn from 245 students of the mainstream private schools of Karachi through convenience sampling. From the collected data, scores of 199 students who attained cut off average fluid intelligence score were analyzed. This pool of scores included 115 high achievers and 84 underachievers. Fluid intelligence was measured through Standard Progressive Matrices (SPM; Raven, 1983) and the previous exam overall percentage was used as a parameter for measuring academic achievement. Statistical analysis using SPSS revealed a significant positive association between academic achievement and fluid intelligence. Results also indicated a significant difference of fluid intelligence between high academic achievers and underachievers. Further theoretical and practical implications for schools and researchers are discussed in detail. Furthermore, the utility of understanding the role of fluid intelligence in academic achievement among adolescents will be explored.

KEYWORDS: Academic Achievement, Adolescents, Fluid Intelligence, High Achievers, Underachievers

INTRODUCTION

Academic achievement is the biggest and a complex environmental intervention contributing to the development of an individual. An extensive amount of research has been done in order to establish a relationship between intelligence and academic achievement in different domains such as health, wealth, education and job performance. A lot of research efforts have been concentrated in investigating a crucial role played by intelligence in learning outcomes and academic performance at educational settings. Sternberg (1997) described intelligence as the high level mental ability. Gardner (1983) formulated Multiple Intelligence (MI) theory where he defines that MI is a popular approach to describe and characterize the ways in which learners learn and respond which is unique. Multiple Intelligence theory involves various aspects of intelligence such as linguistics, logical, mathematical, spatial, musical, kinesthetic, intrapersonal, interpersonal and emotional. According to the theoretical framework, intelligence is a multi-dimensional notion which was initially considered as a uni-dimensional concept in 1905 and was later as a multi-dimensional concept in 1983. Terman (1967) introduced the term Intelligence Quotient (IQ) which mainly focused on cognitive abilities such as problem solving and memory, and during the first half of the 20th century were regarded as an adequate measure of intelligence which is later disregarded.

Academic achievement is defined as mastering a specific content based on specific knowledge and skills. The word academic achievement connotes accomplishment by effort in contrast to academic ability which is less environmentally influential in comparison to academic achievement. For centuries, intelligence is used as determinant of academic achievement which demarcates achievers and underachievers. According of Ries and McCoach (2000), underachievement is defined as an actual gap between the real potential and the actual performance. For the last few decades, researchers have understood the importance of understanding the dynamics of underachievement and explored it with various studies (McCoach & Siegle, 2011; Smith, 2005). These explanations led to different kinds of underachievers thus, identifying multiple causes and combinations of these factors contributing to underachievement of adolescents in educational settings. Rimm (2006) in his exploratory research study identified various factors among middle school adolescents including constantly fearing about his intelligence, his self-image, escalating competitive attitude with classmates and demanding school curriculum which makes them vulnerable to underachievement. Additionally, he proposed that no biological nor neurological explanations account for underachievement in the literature thus, indicating that underachievement is a learnt academic behavior. Moreover, he directed towards the need of exploring the main mechanisms of the child's education; the home and the school. Younger, Warrington and McLellan, (2005) have also reported that, the underachievement is a complex and multi-dimensional issue.

General intelligence also referred as fluid intelligence was defined by Martinez, (2000) as the ability to understand complex relationships and solve novel problems. Fluid intelligence is usually measured by administering tests that involves deductive and inductive reasoning, which reflects the ability of an individual to think, reflect and solve complex problems based on logical reasoning and make inferences in significant way. Several researchers have concluded that there is empirical evidence for a strong relationship between fluid intelligence (also called as general cognitive abilities) and academic achievement (McArdle & Woodcock, 1998 and Kvist & Gustafsson, 2008). According to longitudinal growth modelling, fluid intelligence predicts not only the level of achievement, but also the rate of learning and achievement. However, the nature of the relationship among fluid intelligence and academic achievement is still inconclusive and requires further experimental validation.

It is noteworthy to understand the fact that according to conventional methods, academic achievement is only measured by administering tests in order to assess and validate the information formally taught in the schools. As a wider concept according to Schneider and McGrew (2012), academic achievement is also closely related to crystallized intelligence which focusses on the depth and breadth of the knowledge, based on the values of one’s culture. Accordingly, intelligence is highly correlated to potential whereas, achievement is related to the execution of the potential. Although both intelligence and achievement are considered as the separate entities but are viewed as two overlapping aspects of Catell’s Investment Theory. According to Catell’s Investment Theory, fluid intelligence is the underlying cause of achievement because more capacity to learn predicts more efficient and rapid learning. Based on potentials and capacities of learning, it is invested into experiences and significantly transforms into knowledge. Various other factors apart from intelligence such as motivation, persistence, determination, formal education and personal experiences play role in transforming potential to fulfilled potential.

In short, the aim of the study is to outline the students from different schools to assess the predictive validity thus, examining if there is a correlation between intelligence and academic achievement. Furthermore, the study aims to evaluate that whether intelligence is the robust predictor of academic achievement among adolescents. The verification of the

relationship existing between the student's intelligence and academic achievement is carried out by testing following hypothesis:

- There would be a relationship between fluid intelligence and academic achievement.
- There would be a difference of fluid intelligence between high achievers and underachievers.

LITERATURE REVIEW

Several studies are documented in the literature where researchers have made utmost efforts to establish a relationship between various social factors and personality traits. According to a study by Gracia, F. et al., a relationship between general intelligence, competencies and academic achievement among university students was investigated. The primary aim of the study was to validate the existing relationship between the student's general intelligence and the perception of competencies a student possess including academic achievement. The study involved analysis of a sample of 343 university students where students were evaluated regarding their core competencies and academic achievement based on self-evaluated questionnaire on a scale of (1-10). A factorial analysis to all the competencies (30 general and 10 specific) were applied which elucidated a significant relationship between general intelligence and academic achievement with a p-value of 0.001 and for other non-specific competencies and academic achievement the p-value is 0.005(Cano-Garcia, F., & Hughes, E. H., 2000).

According to a study by Samuel Greiff and Jonas C. Neubert (2015), complex problem solving skills is an important cognitive skill, which is widely used in number of educational achievements. However, it is important to understand that despite of the wider prevalence, the validity of the construct and empirical understanding of complex problem solving skills is feebly understood. The study aims to evaluate internal structure of complex problem solving skills and establishing a relationship between complex problem solving skills, fluid intelligence and academic achievement. The results indicated that the relationship between complex problem solving skills, fluid intelligence and academic achievement exhibited moderate correlations. Overall, the study highpoints role of complex problem solving skills, in predicting academic achievement and fluid intelligence, and further advances knowledge of complex problem skills, in the capacity of fluid intelligence under educational context (Greiff, S. & Neubert C. J., 2015).

A recent study by Treena Rohde and Lee Anne Thompson (2009), examined a direct relationship between IQ and GPA and SAT scores. Two different IQ tests were used in the study, to measure fluid intelligence i.e., Ravens Advanced Progressive Matrices and Mill Hill Vocabulary Scales. Ravens Advanced Progressive Matrices is an effective measure of problem solving ability, in novel situations, such as fluid intelligence and Mill Hill Vocabulary Scales is a good measure of verbal intelligence i.e., crystallized intelligence. According to the results of the study, fluid and crystallized intelligence are by far the most important predictors of academic achievement, along with other factors. Crystallized intelligence is not significantly linked to GPA however; demonstrate a striking positive correlation between SAT scores and crystallized intelligence. On the other hand, fluid intelligence shows a combined correlation of 0.40, with GPA and SAT scores, as significant measures of academic achievement (Rhode, T & Thompson, Anne L., 2009).

Rohde & Thompson, (2007) explained variation in academic achievement, with general cognitive ability and specific cognitive abilities, Grade Point Average and SAT scores were used as parameters, to measure academic achievement and working memory, processing speed and spatial abilities were specific cognitive abilities of interest. The results of the study concluded that, there is 51% to 75% of the variance in academic achievement that could be

accounted by general cognitive ability, alone. Furthermore, he emphasized that, the exploration of the nature of the relationship between general cognitive ability and academic achievement, can lead to widespread implications in theoretical and practical interventions, in academic settings (Rohde & Thompson, 2007).

Similarly, Jensen, (1998) found that, the academic achievement of students in high school was strongly associated (0.50 to 0.70) with intelligence scores. Laidra, Pullmann, & Allik, (2007) proposed that, intelligence is causally related to achievement, reporting that, students' achievement relies most strongly on their cognitive abilities, through all grade levels.

However, Luo, Thompson, & Detterman, (2003) in their exploratory study, highlighted on the association of general cognitive abilities and academic achievement showed that, in the beginning, the divided variance between general intelligence and academic achievement was nearly 30%, but when mental speed component (one of the component of general intelligence) was controlled, the shared variance between general intelligence and academic achievement was decreased to approximately to 6%. It was concluded that, the relationship between general intelligence and academic achievement was in large part, associated with a mental speed component of general intelligence.

Watkins, Lei, & Canivez, (2007) also pointed the existence of considerable debate, regarding the causal precedence of intelligence and academic achievement. According to their review, some researchers view intelligence and achievement as identical paradigms whereas, others found the relationship between intelligence and achievement is reciprocal. Still, others confirm the association between general cognitive abilities and academic achievement (Laidra, Pullmann, & Allik, 2007).

MATERIALS AND METHODS

Participants

Schools were selected through convenient sampling and voluntarily took part in the study, by signing the letter of permission for data collection. All the schools were mainstream private schools of Karachi. Two hundred and forty five adolescent students of these schools, participated in the research study. All the participants belonged to 8th standard. Scores of forty six participants were not included in the analysis process as their fluid intelligence was below average which didn't qualify as underachievers in the present study. Conclusively, One ninety nine participants became part of the study (102 males and 97 females). The age of students ranged from 13 to 16 years with the mean age of 13.14 years.

The Scores achieved on the Standard Progressive Matrices, Pakistani norms Ahmed, (2008) were used for predictive scores of fluid intelligence in the present study. The standard definition of academic achievement followed in the study outlines participant's last year's achieved overall percentage was considered as their achievement level. Students who performed according to the expected performance of school that is 75 or above 75 percentages were considered as high achievers and those participants who achieved below 75 percent but attained at least average intellectual capacity level in Standard progressive Matrices test were considered as underachievers. The selection of 75 percentage as a cut point for the classification of achievement level was based on interviews that were taken from school's upper management (either principal or section head, based on their availability).

Measures

Measures used for this study were **(a)** Demographic Information form &**(b**) Standard Progressive Matrices (SPM) (Raven, 1983)revised and updated in 2008 as per Pakistani norms.

Demographic Information

Demographic information form was designed to evaluate the information related to the participant's personal and educational profile. This included participant's name (optional), age, gender, school name and grade/class. Achieved percentage in last final exams was also included in this section(which was later verified with school records).

Standard Progressive Matrices

Pakistani norms established by Ahmed, (2008) were used for the scoring of participants' scores in accordance with the classic forms of Standard Progressive Matrices (Raven, 1983) suggesting that at a specific point of time, the norms are stable across cultures but have changed dramatically over the passage of time. This measure is used to assess the fluid intelligence of participants. The (SPM) is widely used for measuring abstract reasoning and is considered as a nonverbal estimate of fluid intelligence. (Bilker, et. al. 2012). Researchers from all the five continents have witnessed the good psychometric properties of SPM. Therefore, it is widely accepted and used intelligence scale (Murphy & Davidshofer, 1998; Kline, 2000; Irvine & Berry, 1988; Sbaibi, Aboussaleh & Ahami, (2014). Similarly, normative data from the standardization of Raven's Progressive Standard Matrices in Kuwait in international context is used (Ahmed Abdel Khaleq & John Raven, 2015).

The Standard Progressive Matrices (SPM) scale consists of 60 problems divided into five sets. Each set holds 12 problems. The order of the problems provides the standard training in the approach of working. The five sets provide five opportunities for grasping the method of solving items. In whole, the sets offer five progressive assessments of an individual's intellectual capacity level i.e. Fluid intelligence.

For the present study, the norms of the test were followed by a local study conducted to develop local/national norms for the use of the classic form of the Standard progressive matrices in Pakistan. (Ahmed, Khanam.,& Riaz, 2008). The Raven's standard progressive matrices split half reliability in Pakistan was found to be 0.89, showing good stability and high consistency. The validity of 0.26 was found when it was correlated with 'DRAW A MAN" test (Ahmed, 2008).

Procedure

Authorities of selected schools were contacted and permissions were taken prior. On the day of data collection, the students were asked for their voluntary participation in research. The participants were also assured about the confidentiality of their provided information and test results. Then questionnaires were distributed among students. Demographic items were read aloud for students so they could answer all questions. Further, Participants were provided with the record forms of SPM test. They were asked to fill in particulars related to them on the record form. When they were done, test booklets were distributed among participants. According to standard instructions provided in SPM manual, SPM was administered to students. Lastly, data was analyzed through statistical software package SPSS.

RESULTS

Results of the present study supported both of the formulated hypotheses. **Table 1** presents significant relationship between fluid intelligence and academic achievement ($r = 0.327$, $p = 0.00$). Further, **Table 2** shows the significant predictive power of fluid intelligence. Liner regression showed that the variance caused by fluid intelligence in academic achievement is 10.6%. ($R^2 = 0.106$, $F(1) = 28.96$, $p = 0.00$). Moreover, **Table 3** shows the results of independent

sample t- test. *t* (197) = 4.388, *p*=.000, *d* = 0.642. It shows the significant difference of fluid intelligence between high achievers (n = 115, M = 42.504, SD = 6.315) and underachievers (n = 84, M = 38.88, SD = 4.877). Means of both group showed that, high achievers possess better abstract thinking then underachievers.

Table 1: Correlation between Fluid Intelligence and Academic Achievement

Variables	N	R	Sig.
Fluid Intelligence &Academic Achievement	199	0.327	0.00

Correlation is significant at 0.00 level (2 –tailed)

Table 1 shows the association between fluid intelligence and academic achievement. The findings displayed a significant positive association (r = 0.327, p= 0.00) between fluid intelligence and academic achievement.

Table 2: Regression Table Showing Predictive Power of Fluid Intelligence

Predictor		*B*	SE	R^2	*B*	ΔR^2	F
Model I	Constant	50.745	4.942	0.106	0.326	0.103	28.96
	Intellectual Capacity	0.580	0.119				

Present model found a significant effect of fluid intelligence on Academic Achievement (β = 0.326, t = 4.860, p = 0.00) This model explained 10.6% of variance (R^2 =0.106, F (1) =28.96, p = 0.00).

Table 3: Independent Sample t-test Indicating a Difference of Fluid Intelligence between High Achievers and Underachiever

Variable	High Achievers(n=115)		Underachievers(n=84)		*t(df)*	*Sig.*	*Cohen'd*
	Mean	*SD*	*Mean*	*SD*			
Fluid Intelligence	42.504	6.315	38.88	4.877	4.388	0.00	0.642

An independent sample t test showed that the difference in Fluid intelligence scores between the high achievers (n = 115, M = 42.504, SD = 6.315) and underachievers (n = 84, M = 38.88*, SD =* 4.877*) were statistically significant, t (197) = 4.388, p =.000, d = 0.642*

DISCUSSIONS

The overall goal of the study was to determine the correlation between fluid intelligence and academic achievement and to evaluate the difference in fluid intelligence of high achievers and underachievers. Consistent with the hypothesis, academic achievement and fluid intelligence was correlated. Although our findings were not entirely as hypothesized. This is because the association between academic achievement and fluid intelligence was predicted earlier too.The findings of the present study are similar to those of previous studies (e.g. Watkins, Lei, & Canivez, 2007; Deary, Strand, Smith, & Fernandes, 2007) indicating significant positive relationship between fluid intelligence and academic achievement. Further, results revealed that, fluid intelligence can also predict academic achievement. In addition, the outcomes of the study revealed significant difference between the fluid intelligence of high achievers and underachievers, which contradicts with previous local study of Hasan (2008), concluding no significant difference in fluid intelligence between high achievers and underachievers were evident.

Present results indicate the need of in-depth analysis of independent cognitive variables, associated with academic achievement. Ren et al. (2015) presented a new account of how fluid intelligence affects academic achievement? They divided fluid intelligence into two components including learning component which was associated with the position effect of intelligence items and other was constant component which was independent of the position effect. Findings showed

that the learning component had significant contribution in the prediction of math and verbal performance than the constant component.

Furthermore, Dingfelder, (2005) proposed that, the central component of the brain is responsible for reasoning and problem-solving, which can be enhanced through mental exercises. This knowledge can be helpful in addressing the issue of underachievement. The teachers should be updated with this new knowledge and inculcate such academic activities in class work that help students in particular underachievers to enrich their ability of reasoning and problem solving. Simultaneously, explicitly promoting this notion of possibility will increase intellectual ability and will also facilitate the underachiever in terms of academic achievement as Yeager & Dweck, (2012) argued that, mindset plays an important role. He argued that, advancement in academic performance can be seen, if students are taught or believed that, intellectual abilities are qualities that can be developed and are not fixed.

Cowan, (2000) who studied the role of working memory in enhancement of academic achievement builds on by stating,"It seems to me that children in the training group may have learned to have a better attitude toward the testing situation, whereas children in the control group--who repeated easy problems--may have learned that the testing situation was boring and uninteresting." He added that, the differences aroused on a variety of tasks during mental exercises, among participants in experimental group could be the result of better motivation and attitude, rather than a basic improvement in working memory.

Present findings also highlights that, widely accepted definition of underachievement (eg: McCoach, 2000 & Rimm, 2008), which was the foundation of the present study can only be used to identify underachievers. In accordance with present finding, teachers and educators need to be vigilant to the point that, these underachievers may be performing lower than their own fluid intelligence, but also may not be equally intellectually capable as high achievers. So, it seems equally necessary to work for the advancement of the fluid intelligence of underachievers, with exploring and dealing with other determinants, hindering their academic progress.

Moreover, 84 out of 199 students were identified as underachievers in this study. This alarming figure (42.2%) has indicated an urgent and high need of taking measures to address the phenomena of underachievement. This finding is in congruence with previous findings of Lupert and Pyryt (1996) earlier, which established same results concluding that underachievers were growing in numbers and the numbers significantly increased, as the students progressed from grade 5 to grade 8. Similarly, Battle (2002) also affirmed that, it was during six to eight grades that, a pattern of underachievement consistently emerged in academic assessments.

Related to these findings, it might be interesting to examine and further research various other different sub domains of fluid intelligence, rather than considering as a single homogenous construct. It is quite possible that, different aspects of fluid intelligence are differentially related to both the groups' i.e., high achievers and underachievers. Establishing relationship with differential components of fluid intelligence, would require additional measures of fluid intelligence.

CONCLUSIONS

The present study provides an account of how fluid intelligence influences academic performance, among adolescents. To conclude, the current study validated two hypothesis establishing correlation between fluid intelligence and academic achievement and differences in fluid intelligence of high achievers and underachievers. Furthermore, the results

are in line with the fact that academic learning and achievement is the primary predictor of performance at educational settings. These findings provide a concrete evidence of how fluid intelligence regulates and predicts academic performance and achievement, among high achievers and underachievers and validate the utilization of the intelligence based tools and analysis as educational tools. Furthermore, the empirical evidence supporting hypothesis provides insight to the learning function of fluid intelligence in relation to academic achievement, to acquire strategies and knowledge of various other domains and components of fluid intelligence.

Limitations and Recommendations of the Study

The major limitation of the study is that the data may not be the exact representative of adolescent students nationwide which makes the results of the data irreproducible. Although, finding of this small cohort revealed an urgent requirement of large scale studies in order to understand the interconnection of fluid intelligence and academic performance and their impacts on students in educational settings. Additionally, demographic variables such as gender difference and parent's qualifications are not discussed in this paper, that can illuminate more depth by highlighting other factors, such as social status, formal education, role of parents and gender differences explaining the phenomena and causes of underachievement. Additionally, advanced statistical analysis of data will allow inferring other interfering parameters, on fluid intelligence.

Implications of the Study

Role of educators and school psychologists are strongly illuminated, through this study in school settings. They need to help teachers in planning their lessons, in cognitively stimulating and challenging manner, which sharpen student's intelligence leading to better academic results and will open doors for them, for the future opportunities available in a global ferocious and a competitive world.

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