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Non Cognitive Predictors of Academic Success: A Study Of Engineering Undergraduates

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Abstract:
The study was conducted to predict the non cognitive factors affecting the academic success among B.Tech students of Punjab. 395 B.Tech students from metropolitan districts of Punjab were selected and information was collected from them using 5 point Likert scale. The results revealed that academic success among UG students of engineering was predicted by all non cognitive skills with critical and innovative thinking skills majorly predicting their success followed by and then global citizenship skills. Interpersonal skills were contributing negatively to their success. The study was further elaborated by analyzing the constituent sub skills of various non cognitive skills predicting the success among respondents.

Keywords: *Academic Success, Non Cognitive skills, Management students*

I. INTRODUCTION

Academic performance is the major predictor of student's success, and it is the most general outcome investigated by researchers interested in non-cognitive construct. A strong relationship has been explored between non-cognitive skills and performance in academics at school on the basis of various cross sectional and longitudinal studies. Results of various studies conducted at international level revealed that middle school student's achievement in math, science and reading can be predicted on the basis of their self-efficacy and self-concept as compared to their adjustment to certain demographic factors like attendance at school, availability of learning material at home (Lee et al.2014). Reeves et al. (2014) also established a strong connection between students drive to achieve and their self-control with their overall outcomes.

Success of student is the primary product of university education (Kuh et. al., 2006). In the context of University, success of student is understood a cognitive activity which results into accomplishment in academics, the procuring anticipated cognitive output, know-how and capabilities in graduation as well as in post-university performance (Braxton, 2006; Gonsalves & Vijaya, 2008; Jennings et. al., 2013; Perna& Thomas, 2006). Such idealized and principled expectations arelevied on students and teachers in the form of guiding policies, and exerts great deal of influence upon final policies and procedures to be followed (Harpe et. al., 2009; Oliver, 2013). Though, viewing from the lens of developmental psychology, success of student is multidimensional in its nature, extends beyond the retention-oriented outcomes and mere graduation, as it encompasses development of individuality and cognitive and social maturity as well. At university level, student success is identified in terms of grasping academic content, retention of information, concluding graduation with good score, attaining success at personal front, progressing as per individual differences, indulging into holistic processes of student engagement, and developing social skills. The importance of the seat tributes differs as per role as senior administrators emphasize

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on retention and graduation; academicians emphasize on content, students and professionals emphasize on personal success (Seifert et al., 2014).

College success is a term used interchangeably with academic success or student success as it is related to the success of the students studying in college. Also, with no astonishment it has also been observed that various investigators are themselves skeptical to mention that what actually constitutes the success of student? Nowadays a greater number of people are using this term as universal phrase which engulf plentiful academic outcomes of students. However, the term of academic success is found as restricted one, being confined to student's attainment at educational front only. The haziness concerning limited scope of the 'academic success' is mainly attributed to its traditionally accepted viewpoint among masses from long. People's diverse viewpoint of success has resulted into making the concept of academic success unique one.

As per Pascarella & Terrenzini (1980), "Academic success is a measure of a student's academic and intellectual development. Extent of academic integration is determined primarily by the student's academic performance and his or her level of intellectual development." Heckman and Rubinstein (2001) discussed the significance of non-cognitive skills based on GED testing programmeand draw out three major conclusions: Current evaluation system captures only one of the skills required for successful life and evidences show that non-cognitive skills also effect the evaluation and make it more comprehensive. Hence it is pertinent to collect information concerning impact of non-cognitiveskills on education system.

Kyllonen (2012) in his discussion on role of non-cognitive skills in higher education highlighted admissions as one of the major area in which non-cognitive assessment is required. He suggested through his research that adding non-cognitive assessments while testing for admission is likely to lead better student performance in future. He further specified that a placement testing is another important area in higher education whereby adding non-cognitive assessment may lead to better placement decisions.

Bell (2008) carried out an investigation to identify the influence of certain cognitive factors in mediating the effect of non-cognitive factors on GPA also to find out thathow far admission in engineering education can be predicted on the basis of these cognitive and non-cognitive factors. The study was conducted on a sample of 2276 college freshmen students who wished to pursue their majors in engineering. Results of structural model analysis highlighted that cognitive factors facilitated effect of non-cognitive factors on the quantitative GPA for the pre-engineering curriculum.

Lindquist and Vestman (2011) assessed the importance of cognitive and non cognitive abilities for labor markets results using Swedish military enlistment data. The study concluded that cognitive and non cognitive skills influence labor market results in a different way. Non cognitive skills were measured through personal interview and predicted the labor force engagements; incomes at lower end of distribution and salaries of unskilled workers the most.

On the other hand, cognitive skills helped to foresee the remuneration of skilled workers as well as higher order earnings. Moreover, it also came to light that although cognitive skills are pertinent to achieve success in life but non-cognitive skills also play substantial role in avoiding failures and improving these skills give more benefit to disadvantaged children than their cognitive skills.

II. Operational Definition of the Terms

A. Non Cognitive Skills:

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Non-cognitive skills are the patterns of thought, feelings and behaviour (Borghans et al. 2008) of individuals that continues to develop throughout the life (Bloom 1964). These are the transversal competencies including four major domains of skills as described by UNESCO (2013). These competencies include (i) critical and innovative thinking; (ii) inter-personal skills; (iii) intra-personal skills; and (iv)global citizenship which are mutually inclusive. In the present study non cognitive skills as per the concept of UNESCO have been taken to proceed with further investigation.

B. Academic Success

Academic success is defined as the success achieved by the students throughout their educational career. In the present study academic success is defined the aggregate academic achievement of the students in their previous semesters as measured through there GPA or percentages.

III. Objective of the Study

A. To estimate the influence of non cognitive skills on academic success of engineering undergraduates.

Sampling

To determine the sample size for the study investigator explored Punjab Government website to estimate the population of different cities of Punjab. On the basis of population there are five metropolitan cities in Punjab namely Ludhiana, Amritsar, Jalandhar, Patiala and Bathinda respectively in the descending order representing the total population of Punjab. The first four cities were selected for data collection as per convenience and Bathinda was left as it was not feasible to collect data from Bathinda.

There are approximately 250 institutes in Punjab offering B.Tech with an average of 60 seats available in every institute making 15000B.Tech students studying in Punjab. A sample of 450 students enrolled in 3rd, 5th& 7thsemester of B.Tech in various government and private institutes of Punjab was selected for the present study. The institutes for data collection were selected as per the convenience of the researcher (from wherever permissions were granted) and students were further selected from these institutions using stratified random sampling. Out of survey done on 450 respondents, 395 were selected for final analysis of data and survey of 55 respondents was discarded due to incomplete information received from them. Out of 395 students 119 were studying in semester 3rd, 172 were studying in semester 5th& 104 students were studying in semester 7th making approximately 30%, 445 & 26% respectively from three semesters.

IV. Research Tools

A. Self developed battery of non cognitive skills (based on construct of non cognitive skills given by UNESCO) constituting of four skills: Critical & Innovative Thinking skills, Interpersonal skills, Intrapersonal skills and Global citizenship Skills. Non Cognitive Skills Battery is five point Likert scale consisting of total 58 statements classified into four skills.

B. Aggregate percentage or CGPA of students in their previous semesters.

V. Procedure of Data Collection

Investigator used self developed questionnaire of non cognitive skills to collect data from the respondents. The formal permission regarding the data collection was sought from the heads of the institutions and questionnaires were distributed to the respondents after building a rapport with them and giving them the necessary instructions. Data collected from the respondents was scored for further analysis and interpretation.

Objective 1: To determine the set of skills predicting the academic success of B.Tech students.

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Research Question: Which non cognitive skill predicts the academic success of UG students of engineering courses?

To answer this question multiple linear regression was applied by taking non cognitive skills of engineering students as independent variables and their academic success as dependent variable and results are tabulated and discussed as below:

Table 1: Model[b,c] Summary of Multiple Regression Analysis between the Predictor Variables and Outcome Variable (Academic Success) of engineering student

Model	R	R Square	Adjusted R Square	% age Variance	Std. Error of the Estimate
1	0.877[a]	0.769	0.767	76.7	3.78

a. Predictors: (Constant), GCS, IAPS, IPS, CITS
b. Unless noted otherwise, statistics are based only on cases for which Discipline = B.Tech.
c. Dependent Variable: Academic Success

The value of R in table 1 shows the relation between independent and dependent variables i.e. 0.877 indicating high correlation. Further, it is clear from the table that the independent variables CITS, IPS, IAPS & GCS contribute 77% to the academic success of UG students (Adjusted R^2= 0.767) while rest of the 23% contribution is made by some other variables that are not the part of this model.

Table 2: ANOVA[a,b] Summary showing Regression Model Fit

Model		Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	10711.065	4	2677.766	325.338	.000[c]
	Residual	3209.980	390	8.231		
	Total	13921.046	394			

a. Dependent Variable: Academic Success
b. Selecting only cases for which Discipline = B.Tech
c. Predictors: (Constant), GCS, IAPS, IPS, CITS

The ANOVA table above represents that contribution made by the regressor variables is significant on the regressand variable with F= 325.34, p< 0.001 at 0.01 level of significance indicating that both independent variables in the standard model are significantly predictive of the dependent variable. Hence, it can be interpreted that the there is significant impact of variousnon cognitive skills on the academic success among UG students of professional.

Table 3: Coefficients[a,b] showing relative contribution of predictor variables in outcome variable of engineering students

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.	Collinearity Statistics

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		B	Std. Error	Beta			Tolerance	VIF
1	**(Constant)**	12.094	2.260		5.352	.000		
	CITS*	0.708	0.180	0.441	3.937	.000	0.580	1.724
	IPS	-0.110	0.038	-0.122	2.877	.004	0.329	3.043
	IAPS	0.473	0.124	0.426	3.805	.000	0.951	1.051
	GCS	0.180	0.023	0.212	7.705	.000	0.781	1.281

a. Dependent Variable: Academic Success
b. Selecting only cases for which Discipline = B.Tech

**CITS- Critical & Innovative Thinking Skills, IPS- Interpersonal Skills, IAPS-Intrapersonal Skills, GCS- Global Citizenship Skills*

Subsequent to model fit, to estimate the relative contribution made by each predictor variable, the multicollinearity was tested among the predictor variables firstly and the results of collinearity statistics in table 3 yielded Tolerance > 0.2 and VIF (1/Tol) < 5 (Gujrati, 2003) in case of all independent variables indicating that there are no serious multicollinearity issues among independent variables. Therefore, interpreting the results of coefficients from the table above it can be clearly seen that all skills are contributing to the academic success of UG students of engineering courses with $p< 0.05$. The t-value for CITS is 3.397, for IPS is 2.877, for IAPS is 3.805 and for GCS is 7.705 significant at 0.01 level of significance. Also, looking into the standardized β coefficients, it is clear that the maximum contribution in predicting academic success of B.Tech students is made by CITS & IAPS and it is nearly 2 times the contribution made by GCS while IPS is contributing negatively in predicting their success with β= -0.122. So, considering the unstandardized β coefficients i.e. value of B from the table, the performance of engineering students in academics can be predicted using the following regression equation:

Academic Success= 12.094 + (0.708 X CITS) + (-0.110 X IPS) + (0.473 X GCS) + (0.180 X GCS)

Hence, it can be interpreted that academic success of engineering students is well predicted by all non cognitive skills with interpersonal skills contributing negatively to the success of students. The results of the study are supported by Bell (2008) who carried out aninvestigation to determine if cognitive factors mediate the effect of non-cognitive factors (self-concept, study habits, and inquisitiveness) on quantitative grade point average and also determined if these cognitive and non-cognitive factors can predict admission status in engineering education. The results suggested that the participants who wereenrolled in engineering and those who left unsuccessful were classified correctly based on the cognitive and non-cognitive factors with overall percentage of correctly classified cases as 51.6%. The model accounted for 29% of the variance in the quantitative GPA.

Extending the analysis to predict a definite model constituting the specific sub skills to estimate the academic success among UG students of various disciplines, high achievers were selected from all the disciplines i.e. the students with aggregate

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percentage 75 or above (as per UGC guidelines students with > or equal to 75% are outstanding performers) in their previous semesters. A data of 128 students wasfiltered out from the collected data fulfilling above conditions and specific skill set was determined by applying multiple linear regression and results are interpreted as below:

Table 4: Model[b,c] Summary of Multiple Regression Analysis between the Predictor Variables and Outcome Variable (Academic Success) of B.Tech students.

Model Summary[a]

Model	R	R Square	Adjusted R Square	%age Variance	Std. Error of the Estimate
1	0.867[b]	0.751	0.748	74.8	0.429

a. Discipline = 1

b. Predictors: (Constant), TCPP, TI, TCR, TC, TRE, TDM, TRT, TCP, TCY, TER, TCL, TS, TO, TSD, TIU, TT, TP

The regression was applied to predict the contribution made by independent variables in determining the total variance of dependent variable and from table 4 it is clear that the independent variables contribute 75% to the academic success of UG students of engineering (Adjusted R^2= 0.751) while rest of the 25% contribution is made by some other variables that are not the part of this model.

Table 5: ANOVA[a,b] Summary showing Regression Model Fit

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1196.963	17	70.410	383.108	.000[c]
	Residual	20.216	110	.184		
	Total	1217.180	127			

a. Discipline = 1

b. Dependent Variable: Percentage

Predictors: (Constant), TCPP, TI, TCR, TC, TRE, TDM
TO, TSD, TIU, TT, TP

The ANOVA table above represents that contribution ma
significant on the regressand variable with F= 383.11
significance indicating that all independent variables in the
predictive of the dependent variable.

Table 6: Coefficients[a,b] showing Relative Contribution of Predictor Variables in Outcome Variable of B.Tech students

Model			Unstandardized Coefficients		Standardized Coefficients	t	Sig.
			B	Std. Error	Beta		
1	CITS	(Constant)	66.214	1.379		48.024	0.000
		CR*	-0.007	0.022	-0.004	-0.306	0.760
		ER	0.462	0.142	0.261	-3.243	0.002
		DM	0.161	0.180	0.069	0.891	0.375
		RT	0.541	0.158	-0.299	-3.433	0.001
	IPS	CL	0.006	0.125	0.004	4.051	0.009
		CY	0.271	0.188	-0.179	-2.241	0.023

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		TW	0.107	0.184	-0.070	-2.180	0.013
		I	0.005	0.015	0.005	1.362	0.718
		S	0.070	0.157	0.049	0.449	0.655
		C	-0.830	0.156	0.421	-5.329	0.000
	IAPS	**SD**	0.087	0.136	0.072	2.263	0.027
		P	0.630	0.150	0.614	4.194	0.000
		CP	0.161	0.117	-0.115	-3.371	0.043
	GCS	**O**	0.677	0.115	0.617	5.914	0.000
		IU	0.235	0.104	0.259	2.249	0.027
		RE	0.944	0.121	0.674	7.829	0.000
		CPP	-0.148	0.122	-0.090	-1.208	0.230

a. Discipline = 1

Dependent Variable: Percentage

**CR-Creativity, ER- Entrepreneurship & Resourcefulness, DM- Reasoned Decision Making, RT- Reflective Thinking, CL- Communication & Leadership, TW- Teamwork, I-Initiative, S- Sociability, C-Collaboration, CY- Collegiality, SD- Self Discipline, P-Persistence, CP- Compassion, O-Openness, IU- Intercultural Understanding, RE-Respect for Environment, CPP- Civic & Political Participation*

Subsequent to model fit, the relative contribution made by each predictor variable was estimated by calculating standardized regression coefficients and interpreting the results from the table above it can be clearly seen that in case of critical and innovative thinking skills only two sub skills i.e. entrepreneurial skills & resourcefulness and reflective thinking skills are contributing to the academic success of engineering students significantly with $p< 0.05$ (t= 3.243, 3.443 respectively) at 0.05 level of significance. The standardized β coefficients came out to be 0.261 & 0.069 respectively for entrepreneurial skills & resourcefulness and skill of reflective thinking indicating that entrepreneurial skills & resourcefulness are contributing approximately four times to the success of students relative to reflective thinking .

Adding on to this, the model estimated that out of six sub skills constituting the interpersonal skills four skills predicted the academic success of respondents significantly. These four skills are communication & leadership, collegiality, teamwork and collaboration with $p < 0.05$ (t= 4.051, 2.241, 2.180 & 5.329 respectively) at 0.05 level of significance. The standardized β coefficients came out to be 0.004, -0.179, -0.070 & 0.049 indicating that maximum contribution is made by communication & leadership skills while collegiality and teamwork is contributing negatively to success among students. On the other hand all the three skills constituting intrapersonal skills namely self discipline, persistence and compassion predicted academic success among engineering students significantly with $p< 0.05$ again (t= 2.263, 4.194 & 3.371 respectively). The standardized β coefficients came out to be 0.072, 0.614 & -0.115 revealing that skill of persistence is predicting success eight times better than skill of self discipline while compassion is contributing negatively to the success of the respondents.

Further, in case of global citizenship skills all the sub skills except for civic and political participation predicted the academic success among B.Tech students. The t-value in case of openness is 5.194, for intercultural understanding the t-value came out to be 2.249 and in case of

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respect for environment t comes out to be 7.829 indicating that these three skills are predicting the academic success among respondents significantly at 95% confidence interval. The standardized β coefficients revealed that maximum contributing in predicting success is made by skill of respect for environment with β= 0.674 while minimum contribution is made by intercultural understanding (β= 0.259). The results also revealed that the contribution made by openness is approximately twice the contribution made by intercultural understanding and skill of respect for environment can enhance the academic success 2.5 times than skill of intercultural understanding.

So, considering the unstandardized β coefficients i.e. value of B from the table, the performance of engineering students in academics can be predicted using the following regression equation:

Academic Success= 66.214+ (0.462 X ER) + (0.161 X RT) + (0.006 X CL) + (0.271 X CY) + (0.107 X TW) + (-0.830 X C) + (0.087 X SD) + (0.630 X P) + (0.161 X CP) + (0.677 X O) + (0.235 X IU) + (0.944 X RE).

Hence, it can be concluded that success of UG engineering students is predicted significantly by skills of entrepreneurship & resourcefulness, reflective thinking, communication & leadership, collegiality, teamwork, collaboration (contributing negatively), self discipline, persistence, compassion, openness, intercultural understanding and respect for environment.

VI. Recommendations

1. Educational institutions should assess students on predicted skills before giving admission in B.Tech so as to ensure their success in the programme.

2. Students should be assessed on these skills for placements in related organizations. This will facilitate the employers to select the best candidates with potential to excel and work for the growth of their organizations.

1. School students having interest in engineering work on developing these skills among themselves from the beginning of their careers.

VII. Suggestion for Future Research

1. Study could be conducted on a sample of other disciplines of study.

2. The study could be replicated by taking sample from other states of India.

3. For estimating the skill set small sample of outstanding performers was available from the collected data so further studies can be conducted by taking a large sample of high achievers in order to get more authenticated results.

4.

5.

6.

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