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Does Learning Style Predict Academic Performance of Engineering and Technology Students in India?

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Abstract*: Learning styles have been associated with academic performance of engineering and technology students. The aim of the present study was to identify the learning styles of students and investigating the relationship between learning style subscale scores and academic performance, and thereby determining whether the learning styles predict the academic performance of engineering and technology students in India. We used the Index of Learning Styles (ILS) to determine the learning styles of students and used Cumulative Grade Point Average (CGPA) for academic performance. The Pearson correlation, ANOVA and stepwise regression tests were used to find the correlation between academic performance and learning styles, the difference between the academic performance of groups and to identify the predictors of academic performance respectively. The most strongly preferred learning style was sequential (75.1%). The academic performance had a significant positive correlation with age and four learning styles namely sequential, sensing, visual and active (p=0.000). The sequential learning style was the powerful predictor of academic performance of students in comparison to other learning styles (p=0.000). Studying methods of students and teaching approaches of faculty consistent with the sequential and sensing learning styles may increase the academic performance among students enrolled for engineering and technology degree course in the higher education institutions in India.

***Keywords*: Learning style, Academic performance, Students, Engineering and Technology.**

I. INTRODUCTION

Academic performance has been one of the important indicators of students' achievement in higher education institutions as it is associated with getting an admission and/or getting promoted to a higher grade/class. Academic performance is also one of the important criteria for obtaining a degree and getting a job offer through campus or off-campus recruitment drive (Saraswathi, 1991). Empirical evidence from a number of studies carried out across nations found associations between academic performance and learning styles (Dunn 1983; Mc Dermott 1984; Stott 1985; Miller, Always, & McKinley 1987; Leiden, Crosby, & Follmer 1990). It is very true for engineering and technical institutions as a range of students getting enrolled in such campuses have increased manifold over the last decade in the pursuit of obtaining a white-collar job post to the successful completion of a graduate degree. This has led to the rapidly changing compositions of students and faculty in higher education institutions while equitably representing the diversity of larger society (Alfonso and Ganesan 2019). Such emerging trend poses various challenges to higher education faculty including the understanding of students with diverse learning styles and how to cater to their needs in a classroom environment (Tulsi, Poonia, & Priya 2016). This argument is supported by the work of Alfonso and Ganesan (2019) as learning style also has been acknowledged by the higher education faculty as one of the diversity dimensions in the college classrooms in India. Besides, teachers take the principal responsibility of guiding the students on how they should study systematically. Therefore, understanding the learning styles of students becomes inevitable for students themselves and the teaching faculty as their ideas and knowledge presentation have an inconspicuous impact on the learning process and outcomes of their students (Entwistle and McCune 2002; Biggs 1999; Entwistle and McCune 2004). A reasonable way of comprehending the individual differences in a classroom environment is through the understanding of learning styles (Hall 2005) of students and teaching styles of faculty. It has been documented that learning can be optimized if teaching styles of teachers and learning styles of students match and/or the faculty's instructional strategies match the learning styles of students (Zippert 1985; Dowdall 1991; Spoon and Schell, 1998; Felder and Silverman 2002; Dzakiria, Razak, & Mohammed 2004; Fazarro, Pannkuk, Pavelock, & Hubbard 2009; Holliday and Said 2008; Namie, Siraj, Abuzaid, & Shagholi 2010; Tulsi, Poonia, & Priya 2016). These studies provide compelling evidence for a better understanding of the learning styles of graduates in colleges across the nation as learning styles are associated with students' performance.

A few studies have been carried out, especially in the global North, so far as to understand the correlations between learning styles and academic performance using CGPA. In their studies, Zywno (2002); and Zywno and Waalen (2001) found a statistically significant association between learning styles and CGPA. Although variables such as age, gender, rural or urban, intelligence, aptitude,

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previous achievements, motivation, personality trait, etc. affect the academic performance of students, learning style is also significantly correlated (Thomas, Ratcliffe, Woodbury, & Jarman 2002; Dzakiria, Razak, & Mohammed 2004; Bahar 2009; Cutolo and Rochford 2007; Heiman 2006; Johnson and Johnson 2006; Saroj 2013). Studying students' learning styles provides information about their specific preferences and thereby making it easier to understand to create, develop and tailor-make more efficient educational pedagogy. This could enhance students' participation in the educational process and thereby gaining more tangible professional knowledge (Brown et al. 2009). Research on learning styles also brings into limelight how students learn and find answers to questions (Mountford, Jones, & Tucker 2006). However, literature related to the correlation between learning style and academic performance of engineering and technology graduates in the global South including the Indian subcontinent is scant. In this background, the present study attempts to find answers to questions such as a) what type of learning styles do engineering and technology students predominantly have? b) do students with a specific learning style will have better academic performance? and c) to what extent does a learning style predict academic performance?

II. LEARNING STYLES AND ACADEMIC PERFORMANCE

II. A. Learning style as a concept and definition

Students, in general, learn and process information in many different ways and no one student does it in the same way. Washburne (1936) defined learning as "an increase, through experience, of problem-solving ability," i.e., an increase, through experience, of ability to gain goals in spite of obstacles". This definition was criticised for limiting the process of learning into a mathematical equation. According to Richard Gross (2010), "learning is the process of acquiring new, or modifying existing, knowledge, behaviours, skills, values, or preferences". As learning is attributed to a process, learning style is a salient way of an individual learner to collect, organize and transfer information into useful knowledge (Cross 1976). Dunn (2000) defined learning style as "the way in which learner begins to concentrate, process, and retain new and difficult information". Gregore and Ward (1977) operationalised learning style as a characteristic set of behaviours of people that describe how their minds relate to the world and, therefore, how they learn. As Hunt (1979) stated, learning style is all about how students learn and not about what they learn. According to Kolb (1984), learning style is the preferred way that the individual deals with the given information and how she/he constructs meaning out of the stimuli. Considering various definitions, O'keefe and Nadel (1978) concluded learning styles as cognitive, affective and physiological characteristics that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. The same definition of learning style was later supported by Keefe and Languis (1983).

When it comes to learning, some students prefer to work with more concrete and tangible information (e.g. facts and figures), while others prefer to work more with abstract information (e.g. concepts and theories). A few students incline to use visual cues and presentations to learn as opposed to those prefer the verbalization of information to learn (Felder and Spurlin 2005). Some students may prefer to learn in small incremental steps, while others prefer to learn in large leaps (Felder & Spurlin, 2005). Learners tend to perceive and process information in a continuum from concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). Therefore, every student may have a mix of learning styles and typically develops and assimilates what are his/her dominant learning styles through academic experiences.

II. B. Classifications of learning styles

There are various classifications of learning styles propagated by different researchers over the decades. Learning styles instruments and/or inventories have been developed to classify students based on the learning styles they use while learning. It was reported that there were at least 71 different learning style instruments available for the purpose (Hall and Moseley 2005). Nevertheless, the concept of learning styles is probably credited to David Kolb, who published his model for a learning styles inventory in the year 1984. According to Kolb's Learning Style Inventory, there are four learning styles: i. accommodator, ii. assimilator, iii. converger and iv. diverger (Kolb and Kolb 2005). Learners generally prefer one of the four styles above another. Although Kolb considered learning styles as a continuum that one changes through it over time, usually people come to prefer, and rely on, one style above the others. Students with an accommodating learning style are characterized by concrete experience and active experimentation. These students learn by getting engaged with the world and actively doing things. Students fall in the category of assimilator learning style is characterized by abstract conceptualization and reflective observation. Assimilators usually prefer to think than to act and are good at inductive reasoning and creating theoretical models. Convergers learn best through active experimentation and abstract conceptualization. These students are strong in the practical application of theories. They may like to work by themselves, solve problems and find a practical solution. Students with diverging learning style are characterized by concrete experience and reflective observation. Such students are strong in imaginative ability and view things from multiple perspectives, are open-minded and prefer to work with people.

Later, Kolb's learning styles were given different appellations by Honey and Mumford (2000). They replaced the term activists for accommodators, theorists for assimilators, pragmatist for convergers, and reflectors for divergers. According to Honey and Mumford, activists prefer challenges of new experiences, involvement with others, assimilation and roleplaying. Theorists prefer to think through the problems in a step-by-step manner. Pragmatists apply new learning to actual practice to see if they work. Reflectors prefer to learn by watching, thinking and reviewing. Barbe, Swassing and Milone (1979) proposed three learning modalities such as visual, auditory and kinesthetic. According to them, learning style can occur in isolation and/or in combination, and it can also change over time.

They also brought in the distinction between learning modality strengths and preferences stating that a modality reported by a person may not correspond to his/her empirically measured modality strength (Barbe and Milone, 1981). Expanding the work of Barbe and colleagues (Leite, Svinicki, & Shi 2010) and the representational sensory systems (VAKOG) in neuro-linguistic programming (Fleming 1995), Neil Fleming developed the VARK model. Fleming's four learning modalities are 1.
Visual learning, 2. Aural/Auditory learning, 3. Reading/ Writing, and 4. Kinesthetic (Fleming 2014). The reader has to be aware that there has been a lot of academic deliberations around the difference between the learning style, learning preference, and learning strategy. Sadler-Smith (1996) attempted to clarify these three terms using the onion model. According to him, learning styles are relatively more stable than the learning preferences and strategies that are influenced more by the environment.
As Felder and Spurlin (2005) agreed, learning styles have been investigated in various academic fields including engineering, management, mathematics and natural sciences. Some of the learning styles instruments used for such investigations among science and engineering students include the Myers-Briggs Type Indicator, Herrmann Brain Dominance Instrument, and the Index of Learning Styles (Felder and Brant 2005; Gravenhorst 2007). However, several studies have used the Index of Learning Styles (ILS) developed by Felder and Soloman (1994) to determine the learning styles of engineering and technology students (Montgomery 1995; Rosati 1995; Livesay et al. 2002; Kuri and Truzzi 2002; Smith, Bridge, & Clarke 2002). The ILS was developed based on the extensive research work of Felder and Silverman (1988) who classified learning styles into four dimensions.
According to Felder and Silverman (1988), there are four categories of learning styles namely: Active-Reflective, Sensing-Intuitive, Visual-Verbal, and Sequential-Global. Major characteristics of different learning styles identified by them are portrayed in figure 1.

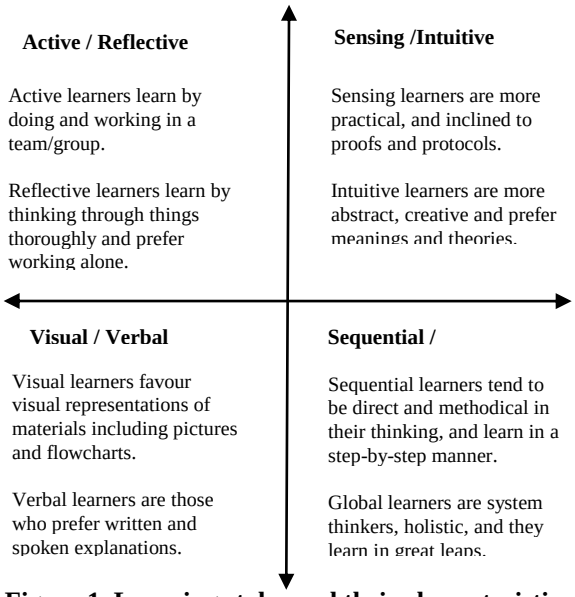

Figure 1. Learning styles and their characteristics by Felder and Silverman

As documented, each student has his/her own attributes linking to his/her process of learning (Reiff 1992). For instance, some students may feel more comfortable to study in a systematic way, while others may do learn better through freestyle learning. Everyone responds to and needs input from all types of learning styles to some extent, but it is a matter of using what fits best with the given situation and a person's learning style preferences that allows the individual to succeed (Kolb 1984). Different learning styles posed in different students will affect their learning process in receiving information, thinking process, communication with teacher or instructor and also their interaction in the class (Junko 1998). However, learning style is often overlooked in the classroom as compared to the instructional activities and method of teaching in the classroom (Sitt-Gohdes 2001). Hence, it is worthy to study the diverse learning styles of students to understand them better in an academic environment to enhance the process of learning and teaching.

II. C. Academic performance

Academic performance is an important variable to measure students' academic accomplishment, and it is a measurable behaviour using standardized tests (Simpson and Weiner 1989; Bruce and Neville 1979) or a set gold standard. Scholars across the world would agree that the college/university system has a set of standard practices when it comes to measuring academic performance. Universally, there is a practice of using Grade Point Average (GPA) as a measure of academic performance; and at the end of a degree programme, a student's academic performance is measured using the Cumulative Grade Point Average (CGPA). In the context of higher education institution, in order to qualify for the award of a college degree, a student must have successfully completed certain courses, achieve certain GPA for the given semesters, and a CGPA for the given degree programme. Thus, academic achievement is not constituted only with a one-point observation of measurable behaviour of a student.
In general, the achievement is viewed as an act of accomplishing something through consistent and continuous endeavours. According to Simpson and Weiner (1989), achievement in the context of education intends to measure systematic education and training towards a conventionally accepted pattern of skills or knowledge. Therefore, measuring the academic performance of college students and studying their learning styles may be combined into an academic achievement series.

II. D. Correlation between learning styles and academic performance

In the past, research studies have been carried out to find the association between learning style and academic performance of students across academic disciplines and a few studies established a close association between learning style and academic performance (Ghazivakili et al. 2014; Good, Ramos, & D'Amore 2013).

As such, learning styles may explain how students learn, and how they are influential in learning and academic achievement (Yazici 2016). It has been documented that both low and average achievers get higher scores on standardized achievement tests when they are taught within the realm of their learning styles (Dunn, Beaudry, & Klavas 1989). Most students tend to learn in particular ways and each learning style contributes to the successful retention of what they have learnt, leading to academic achievement (Felder and Silverman 1988; Felder and Spurlin 2005; Felder and Henriques 1995; Whitman and Schwenk 1984), and these associations were demonstrated among engineering and technology students (Felder and Silverman 1988) as well.

Studies carried out conclude that students, in general, retain "10% of what they read, 26% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say, and 90% of what they say as they do something" (Chuah Chong-Cheng 1988). These findings aid in an inference that students with multiple learning styles, in comparison to students who rely solely on one style, tend to obtain higher academic performance (Dunn, Beaudry & Klavas 1989). Some students may favour experiential, active and hands-on learning, while many others may be more auditory and visually oriented (Dunn 1991). These facts reveal that each learning style has its own strengths and weaknesses, and all these styles have correlations with academic performance. For Simpson and Weiner (1989), academic performance deems to be the journey in which students enquiring complete academic content and skills. Therefore, discussing the learning styles is not only necessary but also important for individuals in academic settings (Chuah Chong-Cheng 1988).

III. METHODOLOGY

For this study purpose, the researchers used a cross-sectional survey design and the respondents were recruited using a purposive sampling method. The study population consisted of engineering and technology students enrolled in the premier technical institutes in the metropolitan cities in India namely: Bangalore, Chennai, Delhi, Hyderabad and Mumbai. The students who completed their first year of BTech in the year 2016 were recruited for this study. We used the following inclusion criteria: (i) age ≥ 18 years, (ii) completed the first year of BTech and continuing in the second year of study (2017) with a required GPA to be officially considered as pass, and (iii) being willing to give voluntary consent and able to participate in the study. Those students with arear in any subject at the end of the first year of BTech degree course and those did not give voluntary consent to participate were excluded from the study. Though a total of 310 students responded to the survey questionnaire before their third-semester examination, 61 questionnaires had more than two missing responses and so those respondents were also excluded. Thus, a total of 249 students form the sample of the present study.

The researcher informed the study participants verbally and in writing about the purpose of the study and written consent was obtained from all the participants who were willing to participate. In order to maintain confidentiality, the personal identifiers of the participants were coded and kept anonymous. The survey questionnaire had variables such as age, gender, followed by the Index of Learning Styles (ILS) to assess the learning styles. The ILS, developed by Felder and Soloman (1994), is a 44-item questionnaire to identify the learning styles of engineering college students. This inventory measures four dimensions of learning styles namely: 1. Active-Reflective, 2. Sensors-Intuitive, 3. Visual-Verbal, and 4. Sequential-Global. Each dimension in the ILS has 11 questions with an answer option of either 'a' 'b' for each question. Where 'a' denotes subscales active, sensing, visual and sequential respectively and 'b' denotes reflective, intuitive, verbal and global respectively. As proposed in the ILS manual, the learning styles grouped according to the similarities of semantics, corresponding characteristics, the associated question numbers and the scoring options are given in Table 1.

Table 1. Semantic groups and associated questions in the ILS

Learning style		Semantic group	ILS questions
Dimension-1	Active	Active learners learn by trying things out and working with others.	1,5,9,13,17,21,25,29,33,37,41 (Answer a)
	Reflective	Reflective learners prefer to think things through and work alone.	1,5,9,13,17,21,25,29,33,37,41 (Answer b)
Dimension-2	Sensing	Sensing learners are practical, oriented towards facts and procedures.	2,6,10,14,18,22,26,30,34,38,42 (Answer a)
	Intuitive	Intuitive learners are more conceptual, innovative and towards theories and meanings.	2,6,10,14,18,22,26,30,34,38,42 (Answer b)
Dimension-3	Visual	Visual learners prefer visual representations of presented material including pictures, diagrams or flowcharts.	3,7,11,15,19,23,27,31,35,39,43 (Answer a)
	Verbal	Verbal learners who prefer written and spoken explanations.	3,7,11,15,19,23,27,31,35,39,43 (Answer b)
Dimension-4	Sequential	Sequential learners tend to be linear and orderly in their thinking and learn in small incremental steps.	4,8,12,16,20,24,28,32,36,40,44 (Answer a)
	Global	Global learners are holistic, systems thinkers who learn in large leaps.	4,8,12,16,20,24,28,32,36,40,44 (Answer b)

The ILS is a well-investigated and often used instrument to identify the learning styles of students pursuing engineering degree programmes. The reliability and validity of the instrument were good (Felder and Spurlin 2005) and other studies also argue that ILS is reliable, valid and suitable (Viola et al. 2006; Felder, Brent, & Prince 2011). The ILS in our study was found to have good reliability (Table 2).

Table 2. Cronbach's alpha reliability coefficients of the ILS

Learning style	Number of items	Number of students	Alpha
Active / Reflective	11	249	0.801
Sensing / Intuitive	11	249	0.883
Visual / Verbal	11	249	0.861
Sequential / Global	11	249	0.894

Besides the variables such as age, gender and learning styles, we also collected the CGPA from the students' transcripts as an actual measure of academic performance. Students' CGPAs of the academic year 2015-2016 were obtained from the Academic Section of the participating higher education institutions. We derived the CGPA by converting the CGPA into marks and then percentages on a scale of 100. The collected data were first entered into Microsoft excel for missing data check. After the quality of the data was assured, data were imported to, coded, re-coded and analysed using the Statistical Package for Social Science (SPSS) version 20. Descriptive statistics were summarized as frequencies and percentages. As the present study data were normally distributed, the correlation coefficients and their significance were calculated using the Pearson test. ANOVA test was carried out to compare academic performance across the groups based on the four learning styles. In order to identify the learning style predictor of academic performance, we have used stepwise regression analysis.

IV. RESULTS

A total of 310 students filled in the survey questionnaire before four weeks of their third-semester examination in 2016. Out of the 310, 61 students' questionnaires had more than two missing responses and/or invalid markings. As a result, valid data obtained from 249 students were used for the analyses. The mean age of the participants was 18.4 years. There were 97 (39%) female and 152 (61%) male participants. As seen in Table 3, the highest per cent (75.1%) of respondents had sequential learning style followed by sensing (70.3%) and visual (67.5%). The least prevalent learning style among the participants was global (24.9%) followed by intuitive (29.7%). Almost 80% had good academic performance.

Table 3. Characteristics and learning styles of study participants

Variable	*(n = 249)*	n	%
Age	18	158	63.5
	19	83	33.3
	20	8	3.2
Gender	Female	97	39.0
	Male	152	61.0
Learning style	Active	139	55.8
	Reflective	110	44.2
	Sensing	175	70.3
	Intuitive	74	29.7
	Visual	168	67.5
	Verbal	81	32.5
	Sequential	187	75.1
	Global	62	24.9
Grade	1st	91	36.5
	2nd	108	43.4
	3rd	41	16.5
	4th	9	3.6

Among the participants, the two predominant learning styles of the female students were sensing and sequential. Whereas, among male students, the two highest prevalent learning styles were sequential and visual (Table 4). However, the difference between both female and male students with regard to the learning styles was statistically insignificant (p >0.05).

Table 4. Learning styles across gender

	Female		Male	
Learning style	n	%	n	%
Active	52	20.9	87	34.9
Reflective	45	18.1	65	26.1
Sensing	71	28.5	104	41.8
Intuitive	26	10.4	48	19.3
Visual	60	24.1	108	43.4
Verbal	37	14.9	44	17.7
Sequential	68	27.3	119	47.8
Global	29	11.6	33	13.3

A strong positive correlation between academic performance and the age of the respondents was found (p=0.000). An insignificant correlation was found between academic performance and gender (p=0.055). Besides, significant positive correlations between the learning styles and academic performance (p=0.000) were also found (Table 5).

Table 5. Correlation matrix of study variables

Variable		Grade		p-value
		Total *(n=249)*		
		n	%	
Age in years	18	158	63.5	0.000
	19	83	33.3	
	20	8	3.2	
Gender	Female	97	39	0.055
	Male	152	61	
Learning style	Active	139	55.8	0.000
	Reflective	110	44.2	
	Sensing	175	70.3	0.000
	Intuitive	74	29.7	
	Visual	168	67.5	0.000
	Verbal	81	32.5	
	Sequential	187	75.1	0.000
	Global	62	24.9	

Regarding the level of learning style preference of the participants, a majority of them had strong preferences for the learning styles such as sequential, sensing, visual and active, in the order of preference. The learning styles with mild preference were verbal, global, intuitive and reflective (Table 6).

Table 6. Learning styles and their level of preference among participants

Learning style	Mild preference	Moderate preference	Strong preference	Total (n=249)
Active	8	67	64	139
Reflective	42	41	27	110
Sensing	6	81	88	175
Intuitive	44	27	3	74
Visual	1	89	78	168
Verbal	49	19	13	81
Sequential	4	98	85	187
Global	46	10	6	62

We grouped the students according to their strongly preferred learning styles (sequential, sensing, visual and active) and the ANOVA test results showed a significant difference in the academic performance of the groups (p=0.000). Regression analysis revealed the sequential learning style as the powerful predictor of academic performance compared to all other learning styles (Table 7).

Table 7. Learning styles as predictors of academic performance

Predictors	Unstd. Coefficients		Std. Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-1.94	1.166		-1.665	0.097
Sequential	0.614	0.107	0.327	5.732	0.000
Sensing	0.576	0.097	0.325	5.962	0.000
Age	0.217	0.064	0.147	3.37	0.001
Visual	0.241	0.1	0.139	2.412	0.017
Active	0.098	0.077	0.06	1.274	0.204
(Constant)	-1.912	1.167		-1.639	0.103
Sequential	0.614	0.107	0.327	5.721	0.000
Sensing	0.606	0.094	0.341	6.449	0.000
Age	0.216	0.064	0.147	3.356	0.001
Visual	0.268	0.098	0.155	2.73	0.007
(Constant)	-2.256	1.175		-1.919	0.056
Sequential	0.748	0.097	0.399	7.741	0.000
Sensing	0.678	0.091	0.382	7.417	0.000
Age	0.236	0.065	0.161	3.648	0.000
(Constant)	2.023	0.074		27.212	0.000
Sequential	0.796	0.098	0.424	8.114	0.000
Sensing	0.722	0.093	0.407	7.785	0.000
(Constant)	2.21	0.078		28.176	0.000
Sequential	1.223	0.09	0.652	13.52	0.000

Note: Dependent variable is CGPA

V. DISCUSSION

The present study assessed the learning styles of Indian engineering and technology undergraduate degree students. Besides, it examined the relationship between students' learning styles and academic performance. The results found the sequential learning style as the most strongly preferred one by the engineering and technology students in India. That is, the students are more methodical and orderly in their thinking and learn in small incremental steps. We also found a significant positive correlation between learning styles (namely sensing, visual and active) and academic performance. However, students with a sequential learning style had statistically higher predictor value for their academic performance when compared to the students with other learning styles. The same result was reported by Felder and Silverman (1988). For the students of engineering and technology, the emphasis should be on organizing teaching information in a linear and orderly fashion with special attention to logically sequenced steps for the students to learn information in an organized and systematic way. When interpreting learning styles, we need to be cognizant of the fact that the learning style preferences are more suggestive of behavioural predispositions than reliable predictors of behaviour (Felder and Silverman 1988).

The engineering and technology courses in these premier engineering and technology institutions in India are highly demanding. Usually, students are admitted to courses in these institutions only after getting through a competitive national entrance examination. Many students start to prepare for such qualifying examinations from the 6th Grade/Class. That is, many students undergo vigorous coaching and training over a period of three to six years apart from their regular schooling to crack the entrance examination for getting admission to a BTech degree in these institutions. So, the teaching and learning approach is profoundly based on systematic and practical training with regular involvement and team/group work. This is probably a reason for the sequential and sensing learning styles preferences.

As stated by Alsop and Ryan (2013), to achieve an optimal learning environment, students must become aware of their personal learning styles and need to have confidence in communicating this. Earlier studies proved that students with greater awareness of their learning styles had better scholastic performance (Nelson et al. 1993; Sandmire and Boyce 2004). It was found that college students who were tested for their learning styles and were given suitable education in accordance with their learning style profile had much higher academic performance than other students (Nelson et al. 1993). Besides, identifying the preferred learning styles of students helps in improving the learning and teaching experiences in a classroom (Graf et al. 2009). It is reasonable to infer that the emotional attribute of students may influence their learning style and thereby their academic performance. There is an emotional and cognitive attribute in relation to academic performance. Because, in terms of the place of learning styles vis-a-vis cognitive styles, the ILS encompasses a combination of both cognitive and learning style scales (Riding and Rayner 1998).

Dunn (1997) has associated predominant learning styles with students from different cultural groups, and it seems reasonable to accept the fact that culture has some influence on learning styles. However, it is important to avoid stereotyping and to recognize that many studies support the view that there is no single or specific learning style emblematic of the members of a cultural, national, racial, ethnic or religious group. All groups comprise of individuals with their own preferences, their own profile of intelligence and learning styles.

The strength of the study is that the first study to be carried out in India to the best of our knowledge, results found the significant predictors of academic performance of engineering and technology students using ILS. There were a couple of limitations to this study. As learning style is subjective and a self-reported measure, it is bound to vary based on experience and the demands of a situation (Cassidy 2004). One must keep in mind that the convenience sampling method and the cross-sectional design could limit the conclusions of this study. Future studies should include students enrolled for the engineering and technology degree in multiple universities across several states to understand the diverse learning styles of students from various geographies in India and the global South.

VI. IMPLICATIONS FOR STUDENTS AND TEACHERS

Learning styles are typical preferences and fortes in the ways that students process and imbibe information. The Felder-Silverman model of learning styles integrates many of the key approaches to understand the learning styles of engineering and technology students.

The ILS was developed to self-test the learning preferences of college and university students, and thereby teachers to organize teaching methodology to aid the students in their process of academic achievement. Each of the four scales of the ILS has two opposite preferences and every student would use every preference at a different time. However, students may not use all the learning styles with the same level of confidence. Hence, the results of the ILS have to be extrapolated carefully to suit the study participants. As evident, these results have implications both for students and faculty in Indian higher education institutions offering BTech degree course. A student with a strong preference for any one of the learning styles may use appropriate learning techniques to help himself/herself in the process of optimal academic achievement. For instance, a student with a strong preference for the sensing learning style may seek out specific examples of concepts and procedures, make connections to the practical realities. Such student may brainstorm with the advising faculty member or with peers, family, or friends about real-world connections. As a sequential learner, a student may learn the material in steps and so s/he can request advising faculty member or a classmate to provide the skipped information. Besides, s/he could consider organizing material in a systematic way and may strengthen global competence by linking new matters to what was already learnt.

Based on the findings, it could be inferred that an exclusive teaching strategy cannot be preferred over the other. Teachers first need to understand students' strongly preferred learning styles at least before venturing into developing instructional strategies. They may need to use an appropriate mix of different instructional strategies to cater to the needs of students with varying learning styles. In this study, as most of the students preferred sequential style, teachers need to follow a linear and systematic step-by-step approach in teaching. With the purpose of maximizing the academic performance of sensing learners, for example, teachers must cite instances from the real world to support concepts, theories, procedures and principles to cater to the needs of sensors.

The faculty in higher education institutions need to be aware of the collective learning styles of their students in order to promote student learning, which in turn would aid in aligning the course delivery in conjunction with students' preferred learning styles. In order to better reach students and maintain their focus in the classroom, the course design/instruction should meet the needs of the students' learning styles (Felder & Brent, 2005). However, this becomes difficult in a classroom with a large student enrolment where learning styles can vary significantly. Nevertheless, learning about the strengths can be empowering and even transformative for students and teachers.

VII. CONCLUSION

The results of this present study found the sequencing learning style as the most common learning style among engineering and technology students in India. Though the four learning styles such as sequential, sensing, visual and active had positive correlations with academic performance, the sensing and sequential learning styles significantly predicted the academic performance of engineering and technology students. Nevertheless, the sequential learning style of engineering and technology students was the most powerful predictor of their academic performance. Teaching strategies consistent with the salient features of the sequential as well as sensing learning styles could improve the academic performance of students. Integrating a step-by-step approach and giving real-life examples to support concepts and theories may facilitate sequential and sensing learning, thus impacting academic performance positively. Creating an enabling classroom environment for students to have systematic and real-life learning may be supportive. Future studies should consider studying the faculty members' teaching styles and their associations with learning styles and academic performance of students in the institutions of engineering and technology.

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