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EVALUATION OF OPTIMUM LEARNING STYLE TO ENHANCE ENGINEERING EDUCATION

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Abstract: *The learning styles differ among individuals according to their characteristics. An appropriate learning style helps the students to achieve excellent academic performance. In this work, the main objective is to determine the learning stylespreference and also the scale of preference midst engineering students. The students' preference is also analyzed and compared between different engineering disciplines. Two hundred students distributed between six disciplines Biotechnology, Civil Engineering, Computer Science and Engineering (CSE), Electronics and Communication Engineering (ECE), Electrical and Electronics Engineering (EEE), and MechanicalEngineering disciplines are considered for analysis. Felder Silverman Learning Style Model (FSLSM) is used to determine the learning style based on four dimensions, and each aspect is sub-analyzed based on the scale of performance as balanced, moderate, and strong. The results of the analysis show that students' preference is high for visual learning style followed byactivist type of learning. The investigation ofthe scale of preference shows that more number of students are balanced, but few students strongly prefer a particular dimension of learning style. Thus identifying the students'specific learning style and educating them according to their choice will help them to enhance individual academic performance and also the overall performance of the institution.*

Keywords: *Learning style, Technical, Engineering, Academic Performance*

I. Introduction

In engineering education, learning style is an integral part of the methodology of obtaining knowledge or talent. The glitches in the understanding level of the diverse Engineering students can be mitigated using the knowledge of their learning style and adopting unique pedagogy, enhancing their cognitive learning capacity, thereby improving their academic performance [1]. The broad categories in technical education have increased the heterogeneity among learners [2], comprising of learners' group with a difference in age, gender, educational

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background, intelligence, personality, rural-urban, learning style, etc. The diverse structure of students in a class directly affects the academic performance influenced by the learning style of learners [2]. Hence, the observation is that the pedagogy matching the learning style of students improves, learning, knowledge acquisition, and academic performance of students [3,4,5]. Busatto et al. proved that learning style contributes to academic success [6].

II. Learning styles

Learning style is considered as a technique by Dunn (1993), which helps the learners to concentrate, process, and retains novel data [7]. Felder (1996) described learning style as a methodology to get facts based on their strength and preferred style [8]. Vermunt (1996) defined learning style as logical concentration and intellectual educatingevents for acquiring knowledge [9]. Keefe (1995) describes learning style as a cognitive character, physiological, and intelligentbehaviour which is used by students to observe, relate, and react to a changing environment [10].

III. Literature Review

The students' approach for acquisition and management of information is analysed using Felder and Silverman (1988) learning style method [11]. Kolb (1984) [12] and Honey and Mumford (1992) [13] proposed learning style as a significant process to collect information and facts and derive a correlation, thus enhancing their knowledge. Dunn and Dunn (1986) [14] evaluated the effects of education concerning the environment, such as classroom arrangement, students count in class, etc. The need for distinct emotional support for self-learning, group study, and the cross-group study was analysed. Physiological reflections in learning were also explained. Sternberg (1997) [15] studied the effectiveness of teaching in the work field. Dunn et al. (2001) [16] discussed the sociological concept, which is influenced by other peoples' thoughts, beliefs, and behaviour. In addition the psychological aspect of learning was experimented (Dunn et al., 2001; Denig, 2004 & Lovelace, 2005) [16,17,18].

Zainon et al. (2009) analyzed the influence of learning style on the educational attainment of the Malaysian taxation course [19]. The correlation between learning styles and whole educational attainment in definite Malaysian learning structure was analyzed by Jafre et al. (2011) [20]. The association between learning styles and educationalattainmentmidstof Malaysian Arts and Science colleges is evaluated by Khalid et al. (2013) [21]. In India, the analysis was performed by Gappi (2013) [22] to find the influence of learning style on the educational attainment of students. Similarly, the consequence of learning style on the educational success of students was studied by Omar et al. (2015) [23].

IV. Materials and Methods

The methodology adopted for this work is a quantitative survey with random sampling because it provides accurate and consistent results [24]. The main objective is to recognize the various learning styles and their impact

on the academic attainment of engineering learners. A survey questionnaire and samples from 200 number of engineering students pursuing their third year from six undergraduate courses comprising of Mechanical, Civil, Biotechnology, Computer Science, Electrical & Electronics, and Electronics & Communication Engineering were analysed.

4.1 Methodology

In the year 1988, Richard Felder and Linda Silverman established the structureentitled the Felder-Silverman Learning Styles Model (FSLM) to categorize the learning style of learners based on four dimensions [11]. The first dimension is subdivided into two categories based on the way they learn new concepts, as active learners and reflective learners, where the active learners are kinesthetic in nature and work in a group. In contrast, the latter group prefers to learn and work in an isolated environment. Kinesthetic learners prefer to participate in all discussions and interact with others and are equipped with communication skills. However, they defer from listening for a prolonged duration and are active only to interactive lecture learning sessions. The second dimension is grouped based on the learners' perception of facts, as sensing and intuitive learners group. The learners with sensing styles are more realistic and believe in concrete facts based on a theory with practical and substantial proof. The intuitive learners are more inventive, creative, and try to discover the relationships. The third dimension is categorized based on the preference for delivery pedagogy based on visual or verbal. The learners, learning better from pictorial representation or flowcharts, or by diagrammatic explanation, are categorized as visual learners, while verbal learners understand from written and oral words. The fourth dimension is grouped based on learners' capability of understanding the facts as sequential and global learners. Learners of the sequential group learn information from minor information grouped into as a full content, thus learning to find a solution using step by step procedure. In contrast, global learners learn randomly, and they connect all information using the process of holistic thinking.

The learning style preferences determined using the FSLSM model, Index of Learning Styles (ILS) questionnaire. The index of learning style questionnaire is centered on the Felder Silverman learning style model that comprised of 44 parameters [11]. ILS articles are separated centered on FSLSM model dimensions, and each aspect comprises 11 parameters with a choice between two responses “x” and “y”, where “x” represents subgroups active, sensing, visual, and sequential while “y” indicates reflective, intuitive, verbal, and global. Concerning the psychometric qualities of ILS, numerous previous work illustrated that the ILS handlesanalytical value and additionalconstancy than other learning style instruments [11]. The ILS items categorized according to semantic similarities,as described in the FSLSM model [7].

The preference for a particular dimension is sub-classified into three scaling categories, such as balanced, moderate, and strong preference. The balanced type refers to a learner with little choice for a specific style of learning and may adapt to other learning styles also. The moderate group refers to the learners’ preference is more

compared to the balanced group learners, for aspecific learning style. The strong category refers that the learner restricts only to a specific learning style.The vital objective of this work is to find and analyze the learning styles among the different courses of engineering students.

V. Results

Table 1 organizes the distribution of the number of students across the six disciplines. Table 2 pictures the spread of the four dimensions of learning style preference in terms of percentage of the total students considered for analysis. From the analysis, it is observed that, based on the first dimension, where 70% of the students prefer activist learners' style, and the remaining 30% are reflector learners. The second dimension was observed to consist of55.5% of students as sensing type learners and 44.5% of students as intuitive learners. The third dimension exhibited 91.5% of students as visual preference learners and 8.5% of students as verbal preference learners. In the fourth dimension, 52% prefer a sequential mode of learning style, and 48% of students prefer a Global learning style. Figure 1 describes the graphical representation of this students' distribution.

Table 1: Number of students across different disciplines

Disciplines	Frequency	Percentage
BIOTECH	40	20.0
CIVIL	10	5.0
CSE	91	45.5
ECE	28	14.0
EEE	22	11.0
MECH	9	4.5

Table 2: Learning styles and their scale of preference among students

Learning Style	Balanced		Moderate		Strong		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Activist	108	54	30	15	2	1	140	70
Reflector	44	22	15	7.5	1	0.5	60	30
Sensing	77	38.5	26	13	8	4	111	55.5
Intuitive	74	37	12	6	3	1.5	89	44.5
Visual	53	26.5	89	44.5	41	20.5	183	91.5
Verbal	15	7.5	2	1	0	0	17	8.5
Sequential	57	28.5	44	22	3	1.5	104	52
Global	75	37.5	20	10	1	0.5	96	48

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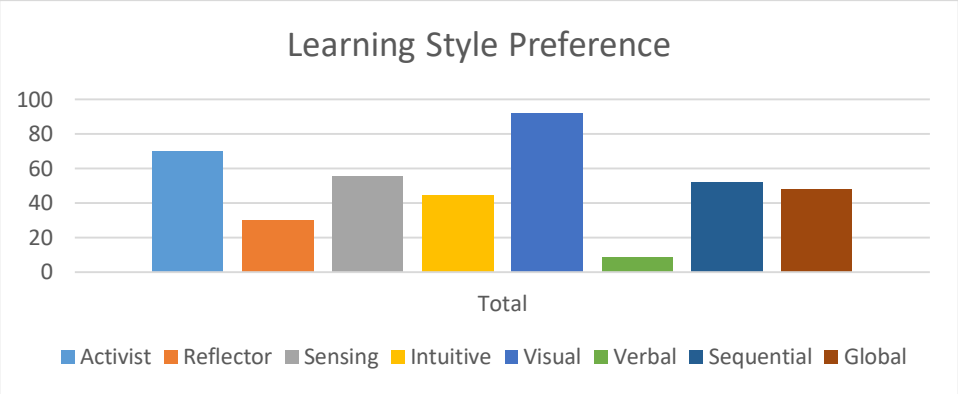

Figure 1: Graphical representation of learning style preference among students

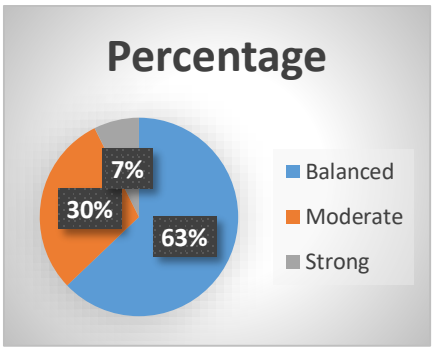

Figure 2: Scale of preference among students

Considering the total number of students and analyzing in terms of scaling strength, 63% of students are balanced; that is, though they incline to a precise learning style, they are capable of balancing with the other learning style. The 30% of learners are moderate, that they prefer for a specific style of learning have little difficulty to adapt with other teaching methodology. The 7% of students have a strong preferencefor a specific learning style, and if the educating methodology does not equal them, they cannot perform well in academics. Figure 2 gives the pictorial distribution of this analysis.

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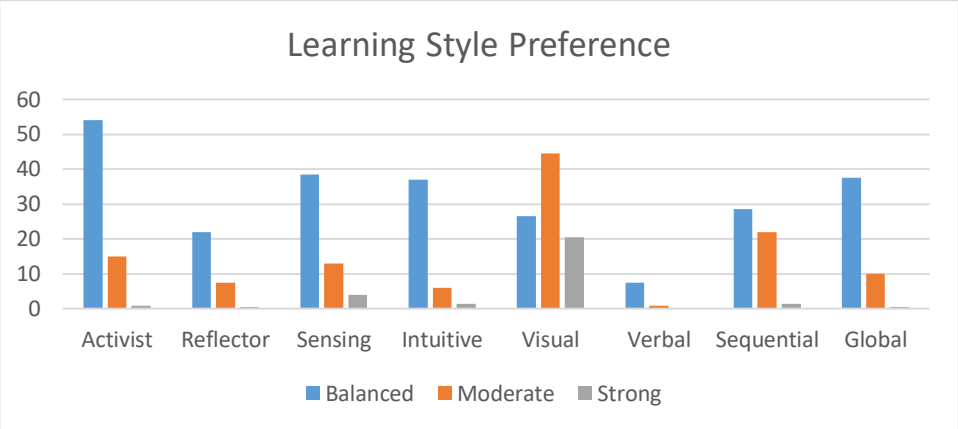

Figure 3: Scale of preference distribution among different dimensions of learning styles

Table 2 shows the analysis based on preference scaling, categorized as balanced, moderate, and strong. A particular learning style was strongly preferred by a maximum of 1.5% of students except for visual learners who preferred by 20.5%. The moderate group had the maximum preference percentage of students as 22% except for visual, which is 44.5%. Similarly, the maximum rate of students for balanced preference strength is 38.5%, except for activists, whose preference strength percentage is 54%. Figure 3 shows the distribution of scaling preference among the different dimensions of learning styles.

Table 3: Learning styles preference distribution among different disciplines

Discipline	**Activist**	**Reflector**	**Sensing**	**Intuitive**	**Visual**	**Verbal**	**Sequential**	**Global**
BIO	65	35	60	40	3	8	50	50
CIV	60	40	60	40	00	0	20	80
CSE	76	24	56	44	5	5	54	46
E	6	3	6	3	8	1	50	5

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CE	8	2	4	6	9	1		0
EEE	68	32	32	68	3	27	55	45
MEC	56	44	56	44	00	0	78	22

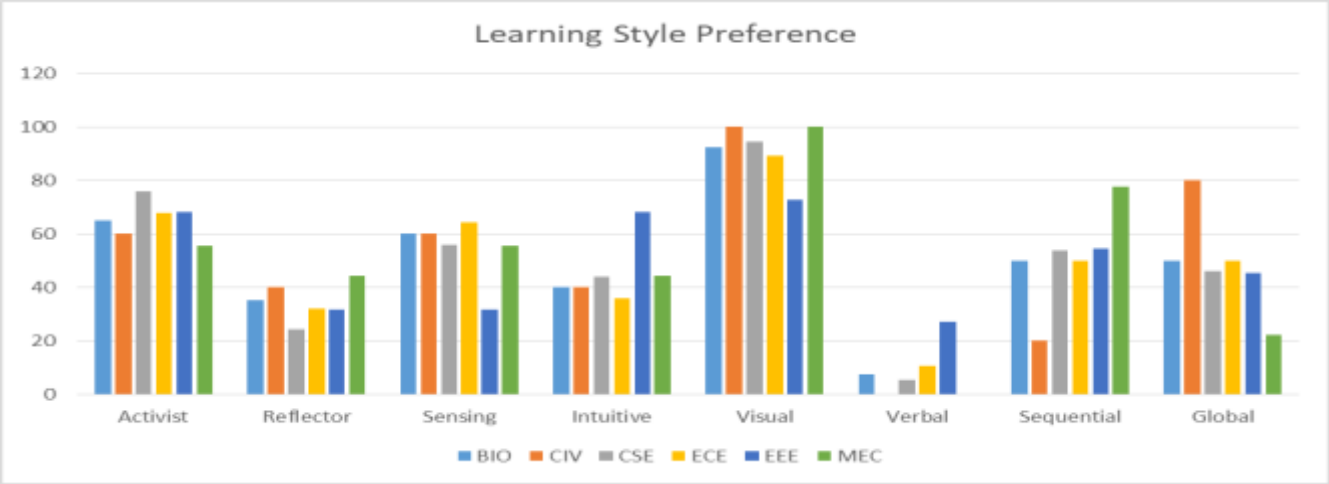

Figure 4: Learning style preference among different disciplines

Table 4: Scale of preference for different learning styles among different disciplines

	Activist			**Reflector**			**Sensing**			**Intuitive**			**Visual**			**Verbal**			**Sequential**			**Global**		
Dis	**balanced**	**moderate**	**strong**	**balanced**	**moderate**	**strong**	**balanced**	**moderate**	**strong**	**balanced**	**moderate**	**strong**	**balanced**	**moderate**	**strong**	**balanced**	**moderate**	**strong**	**balanced**	**moderate**	**strong**	**balanced**	**moderate**	**strong**
IO	8	3		5	0		0	5		8			8	3	3				5	5		8	0	

IV	0	0		0		0	0	0	0	0			0	0	0				0			0	0	
SE	2	4		5			8	2		8			0	2	3				5	6		1		
CE	4	4		5			1			6			8	7	4	1			2	8		2	8	
EE	5	3		7			4	8		6	3		3	2	8	7			2	8		5		
EC	3	2		4			4	1		2	2		3	4	2				7	1		1	1	

Table 3 tabulates the analysis performed for understanding the learning style of students among different disciplines. The activist category of students among different disciplines ranges between 56% -65% and reflector type of students ranges between 24% -44%. In the second group, sensing learning style preference of students ranges between 32% - 60%, while intuitive preference ranges between 36% -68%. In the third group, the visual learning style preferred by students ranges between 73% -100%, while verbal learning style preference ranges between 0% -27%.In the fourth category, the students' preference for sequential dimension ranges between 20% -78%, while the global group ranges between 22% -80%. Figure 4 pictures the students' preference for a particular learning style. Table 4 describes the preference for a particular dimension centered on scaling, that is, balanced, moderate, and strong among students of different disciplines and also among different learning style dimensions.

VI. Discussion

In the first type of analysis, the total students are considered in determining their scale of preference, that is balanced, moderate, or strong, among the four learning styles dimensions. The results show the visual learning style with high preference compared to the verbal learning style. The next most desired learning style is activist compared to the reflector. Hence, it is understood that students prefer peer group learning rather than an isolated learning style. Sensing learning style is preferred compared to intuitive, with meagre difference, which shows that students refrain from remembering and applying theoretical concepts gradually.

Similarly, though the sequential learning style is preferred compared to global, the difference level between them is less due to their lack of opportunities provided to relate their courses to practical examples.Comparing the preference scale, balanced, moderate, and strong, the number of students prefer firmly is less compared to the other

two. For the visual learning style, the preference scale strong is a little high, but still, it is less compared to the other two preference strength. The percentage of students' preference is high for moderate compared to strong, but it is less compared to balance. The same trend of analysis is obtained by the previous research work [2,9, 25,26.27,28].

In the second type of analysis, the comparison is performed between disciplines for various types of learning styles. Amongst the various disciplines, also, the same trend of students' preference is observed, that is, visual, activist, sensing, and sequential, but there is a change of pattern in few cases. The students pursuing EEE prefer intuitive learning style against sensing. Civil Engineering students prefer a global learning style compared to sequential. However, the strength of preference for sequential and global are equal in the case of Biotechnology students and ECE students.

The third dimension of analysis is performed based on the four categories. The activist learning styles preference strength is balanced among a majority of students. The number of students whose preference strength is moderate is less compared to balanced but high compared to strong. Only 5% of students prefer strongly from Biotechnology, and none other department students prefer strongly activist type of learning style. The analysis of the reflector learning preference also follows a similar trend of activist, except for civil, where 10% of students prefer reflector type of learning style strongly, and other disciplines do not prefer strongly. There are no students who prefer a moderate form of the reflector learning style from the civil and mechanical discipline.

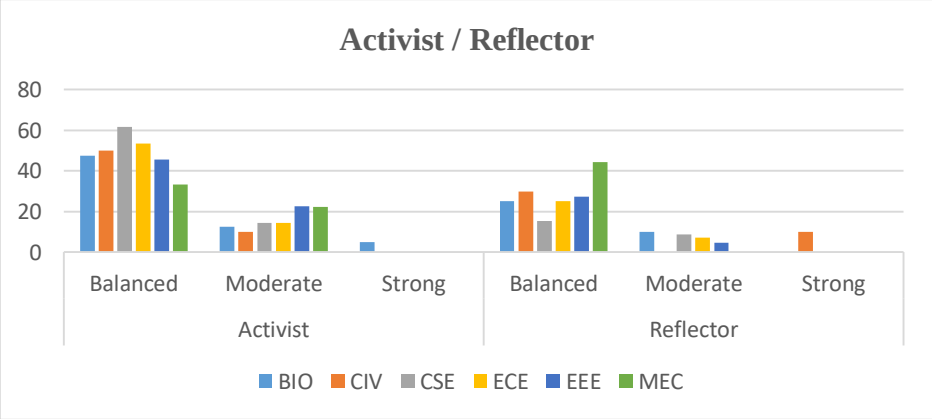

Figure 5: Scale of preference for Activist/Reflector among different disciplines

The sensing trend exhibits the same trend, except for EEE. In EEE, the number of students preferring to learn moderately is high compared to balance.The intuitive learning style depicts the trend followed only in CSE and EEE students. In Biotechnology, none of the students prefer a moderate learning style. In the Civil and ECE discipline, the students' preference strength is only balanced. In mechanical, the students' preference strength is both balanced and moderate, but there are no students who prefer strongly.

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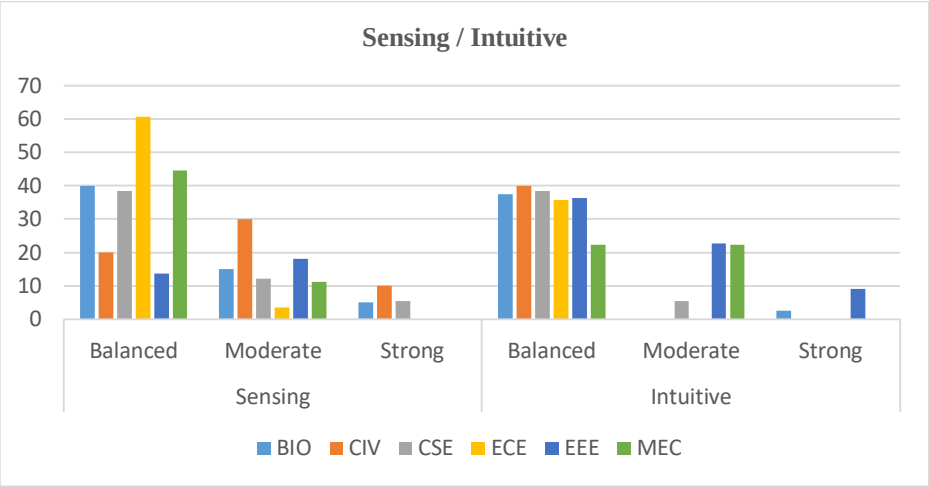

Figure 6: Scale of preference for Sensing/Intuitive among different disciplines

The visual learning style is predominantly preferred by a large number of learners who prefer this learning style moderately and is high compared to the other two in all disciplines except civil discipline. Civil and mechanical students do not prefer verbal learning style. Biotechnology and Civil Engineering follow the same trend. In ECE and EEE, the students' preference strength is only balanced.

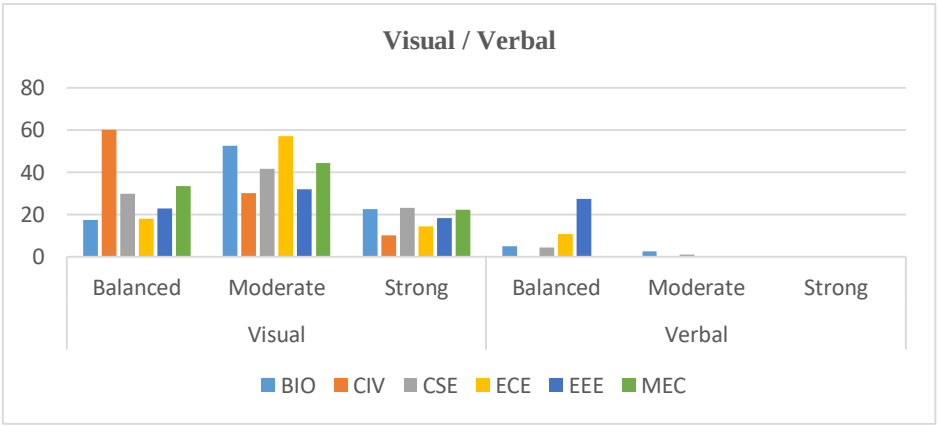

Figure 7: Scale of preference for Visual/Verbal among different disciplines

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ECE, EEE, Mechanical Engineering follow the same trend for sequential learning style. Biotechnology has an equal percentage of students for balanced and moderate preference of learning style, but no students preferred this learning style strongly. In CSE discipline, an almost equal percentage of student's preference strength is balanced and moderate. All disciplines exhibit the same trend towards the global learning style.

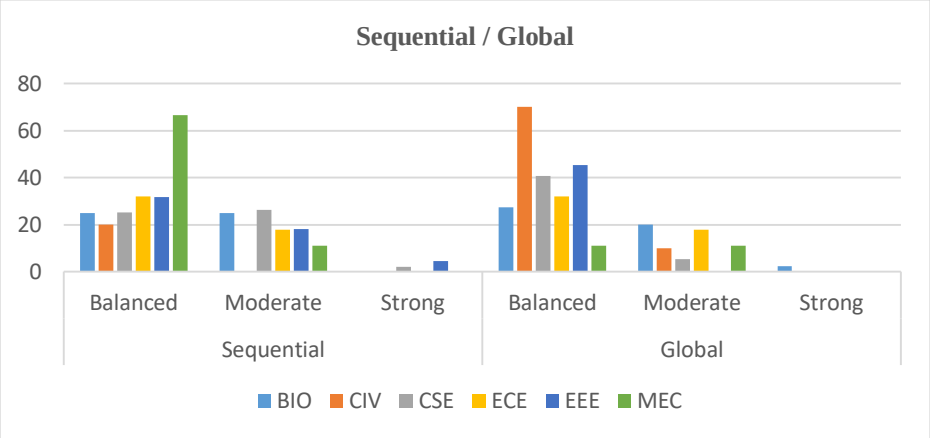

Figure 8: Scale of preference for Sequential/Global among different disciplines

Thus from the information, analysis is performed to interpret the learning style analysis discipline wise. In the disciplines of Biotechnology and ECE, where students with good scores in Physics, Chemistry and Biology are admitted, more students are capable of understanding predominantly from discussions, facts, practical applications, visual representation. These students have common characteristics and hence, 50% of the students prefer linear steps in understanding the concepts and the remaining 50% prefer to understand the concepts randomly.In the discipline of Civil Engineering, 75% of students are capable of understanding from discussions, facts, practical applications, visual representation and random concepts, which is necessary to implement theoretical concepts practically in construction techniques.In the CSE, Mechanical Engineering, as well as in the EEE disciplines, the same scenario exists, which requires students to program the theoretical algorithms and test the theories in existing electrical systems. The enrolled students hailing from similar regions and prior course of study prefer to learn in linear steps or randomly based on the history of their previous education. Table 5 tabulates the disciplinewise analysis.

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Table 5: Learning Style Analysis Discipline wise

Disciplines	First Dimension		Second Dimension		Third Dimension		Fourth Dimension		Remarks
	Activist	Reflector	Sensing	Intuitive	Visual	Verbal	Sequential	Global	
BIOTECH	65	35	60	40	92		50	50	activist, sensing, visual and global
CIVIL	60	40	60	40	100		20	80	activist, sensing, visual and global
CSE	76	24	55	43	95		53	46	activist, sensing, visual and sequential
ECE	68	32	65	36	89	1	50	50	activist, sensing, visual and global
EEE	68	32	32	68	73	7	55	45	activist, intuitive, visual and sequential
MECH	55	44	55	44	100		78	22	activist, sensing, visual and sequential
Majority	Activist		Sensing		Visual		50%-sequential	50% global	

VII. Conclusion:

From the results, it is evident that visual learning style is widely preferred amongst all students irrespective of their diversity in their disciplines. Hence, engineering education can be well imparted to students with efficient

knowledge dissemination through verbal descriptions accompanied by ICT tools. Augmented reality and Virtual reality have captured the minds of students and hence can drastically improve the understanding capability of students, thereby increasing the academic performance exponentially. Similarly, additional learning techniques, including activity-based learning, project-based learning, e-learning, interactive webinars, may be adopted as a teaching pedagogy for the majority of active learners. The technical skills of the students can be nurtured among the students through the conduct of various technical hands-on workshops handled by technical industrial experts with seminars on practical applications in industries. The students may be offered internship and In-plant training from the first year to enhance their understanding and incline them towards engineering. Technical group discussions and interactions may be held in classrooms for the benefit of activists and kinesthetic learners. The curve for intuitive learning style will tend to improve when laboratory-based learning is adopted, with theories implemented practically primarily in mathematical courses that form the core of any engineering discipline. Active learning will also enhance its trend using the e-learning strategy, where they need to activate all their senses to compete globally amongst a diverse student community. These methodologies can be experimented immediately after analyzing the performance of students during the first-semester examination and adopted if the learning and performance curve grow in parallel.

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