Analyzing an Indian Liberal Learning Program

Dr. Pradeep Kashinath Waychal, Guruji Education Foundation

Dr Pradeep Waychal is a founder trustee of Guruji Education Foundation that provides holistic support to the higher education of underprivileged students and a visiting professor of Engineering Education at CRICPE of Western Michigan University, US. Earlier, Dr Waychal has worked at Patni Computer Systems for 20 years in various positions including the head of innovations, NMIMS as the director Shirpur campus, and at College of Engineering Pune (COEP) as the founder head of the innovation Center.

Dr Waychal earned his Ph D in the area of developing Innovation Competencies in Information System Organizations from IIT Bombay and M Tech in Control Engineering from IIT Delhi. He has presented keynote / invited talks in many high prole international conferences and has published papers in peer-reviewed journals. He / his teams have won awards in Engineering Education, Innovation, Six Sigma, and Knowledge Management at international events. His current research interests are engineering education, software engineering, and developing innovative entrepreneurs and intrapreneurs. He has been chosen as one of the five outstanding engineering educators by IUCEE (Indo-universal consortium of engineering education).

Prof. Anil Dattatraya Sahasrabudhe P.E., All India Council for Technical Education

Prof. Anil Sahasrabudhe is currently on deputation from IIT Guwahati as Chairman of AICTE. Prior to joining AICTE, he was Director of College of Engineering Pune where he initiated a large number of educational reforms in teaching-learning pedagogy, innovation, research and entrepreneurship.

Analyzing a liberal learning program at an Indian engineering college

Introduction

Engineering educational institutes must recognize the criticality of lifelong and interdisciplinary learning for the 21st century engineers and change curricula appropriately. Towards that, an Indian college introduced a sophomore level program on liberal learning. It required a radically different paradigm. The Indian K-12 education system does not prepare students for such a program and the Indian engineering education system does not require such a program. The college initiated the program with a careful crafting of a comprehensive framework and executed it successfully. The framework requires students learning liberal areas of their choices, which were analyzed to better understand students.

This paper discusses background of liberal learning and explains the framework. Its process consists of define, harvest, synthesize and share phases; and its data consists of student, area, faculty, sub-area, and cluster entities. The paper also discusses execution of the program, analysis of choices of the areas with respect to students' academic performance, gender, and learning styles, and ends with concluding remarks.

Liberal Learning

Liberal Learning[1] was prevalent in ancient civilizations. Aristotle defined it as learning of a free man. In early university systems, it was defined as education to make students responsible human beings and citizens [1]. Until recently, education systems considered the goals of liberal education separate from the goals of regular education. The Harvard Redbook comments that these two sides (general education and vocational education) of life are not entirely separable, and adds that it would be false to imagine education for the one as quite distinct from education for the other [1]. Today, this thought is gaining wider acceptance. Educators are integrating learning across liberal and specialized education, recognizing that the goals of either are not only similar, but often overlapping[2] [3].

Liberal Learning and Engineering Education

Engineering education started in early to mid-nineteenth century but incorporated liberal education in its regular curriculum, only a few decades ago. In 1968, Olmsted [4] had claimed widespread dissatisfaction with the general, or "humanistic social" part of engineering education. In 2010, Harper et al. articulated engineering educators belief of humanities and social science courses being very important in preparing engineers [5]. Traver and Klein [6] point out that many engineering "grand challenges" require multi-disciplinary approaches including integration of engineering and liberal arts disciplines. Smith [7] observed need to emphasize technological, interpersonal, and socio-technical competence in engineering education. Fisch and MeLeod argue for lifelong learning, "we are currently preparing students for jobs that don't yet exist . . .using technologies that haven't been invented . . . in order to solve problems we don't even know are problems yet" [8]. Shinn [9] is vocal in his support of liberal learning and says that it is a key fiduciary responsibility of college and university boards to not only financially support liberal education at their institutions, but also to oversee its success and integration with students' majors. Steneck et.al [10] assert that liberal learning can contribute significantly to many ABET and

[1] Literature talks about liberal learning, liberal education and general education. They have different but overlapping meaning and coverage. We have defined liberal learning as self-learning for engineering students in non-engineering areas. We have added the self-learning, due to the criticality of that competency for today's engineering graduates.

other international programs' attributes such as functioning in multidisciplinary teams, understanding the impact of engineering solutions in global and societal contexts, and lifelong learning.

Owing to these research findings liberal learning is increasingly becoming an integral part of engineering curricula. Leading institutes like Princeton, Yale, and CMU run programs for engineers to help them gain a clear appreciation of technology and the socio-political forces that shape it. Moreover, Smith College [11] [12], Union College [6], and Binghamton University [13] present approaches to integrate liberal education with engineering education. Waychal and Sahasrabudhe [14] describe the liberal learning program that they implemented at college of engineering, Pune (COEP), in India. The national accrediting agency, ABET expects evidences of students ability to integrate liberal arts and technical competencies [15].

Liberal Learning at an Indian College

Literature refers to liberal learning, liberal education, and general education as courses in non-engineering areas that are required to develop complete professionals. The courses are taught like any other courses and not targeted to develop lifelong learning skills. We attempted a different approach and defined liberal learning as "self-learning in self-chosen (non-engineering) areas with self-defined scope". Our program goals were to inculcate lifelong learning beyond engineering and help students appreciate the interplay between engineering and other disciplines. We included the lifelong learning, due to the criticality of that competency for today's engineering graduates. Our program did not define syllabus, did not identify text or reference books, and did not conduct classroom lectures and regular examinations. Students defined their own syllabi, harvested learning resources, learnt the area to develop their own viewpoints (synthesize), and shared their learning in appropriate ways with their peers and faculty.

Liberal Learning Framework

The way you require navigational tools to chart a new territory, you require a framework to self-learn a new area. Influenced by 'Young learner's handbook'[16], we developed such a framework [14]. Based on the review inputs of the head of the institute, the department chairs, and some faculty members, the framework was enhanced. The framework was targeted not to stifle creativity, freedom or excitement of learning something new but, to work like compass and map, to help learners know their current locations and to provide directions so that they can optimally reach their desired places. We reproduce a relevant portion of the framework in the next sections to set the context.

The framework's data elements are *student, area, faculty mentors, sub area* and *cluster* (figure 1) and are in italics in the forthcoming sections except common terms like students. At the outset, the framework needs the college academic leadership to identify liberal learning *areas* such as philosophy, medicine, social sciences, environmental sciences, sports, and defense studies. The *faculty mentors* are required to have interest, and not expertise in the *area*, and skills to self-learn new areas. The *mentors* and *students* of the *area* meet to identify *sub-areas, external experts*, and to form *clusters* of about fifteen students each with *a student convener* and *a co-convener*. With the help of *faculty mentors*, students decide individual learning *topics* and corresponding *focus questions*.

The process elements are *define, harvest, synthesize* and *share* and are in italics in the forthcoming sections (figure 2). In the *define* phase, each student chooses an *area* and *a sub-area* and identifies *a topic*. The *harvest* phase requires them to gather information from various sources and analyze that information. In the *synthesis* phase, they synthesize a viewpoint based on the analyzed information. The *share* phase entails presenting the learning with the help of reports / articles, presentations, or video films. The framework recommends around one week to *define*, six weeks to *harvest*, four weeks to *synthesize* and three weeks to *share*.

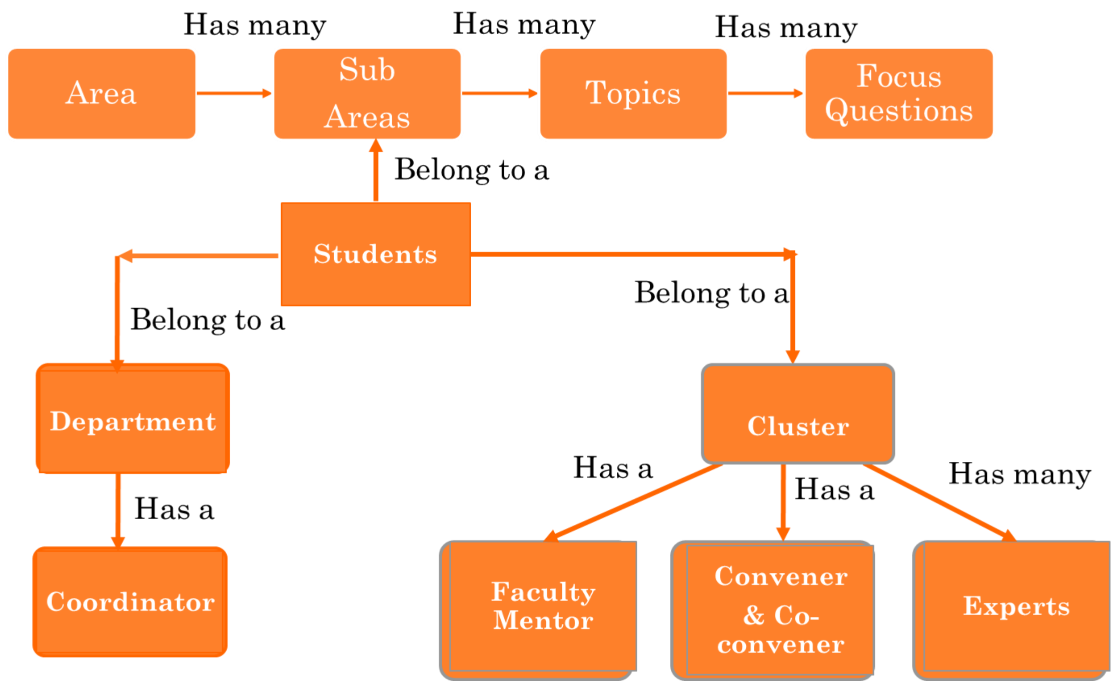

Figure 1: Data elements of the framework

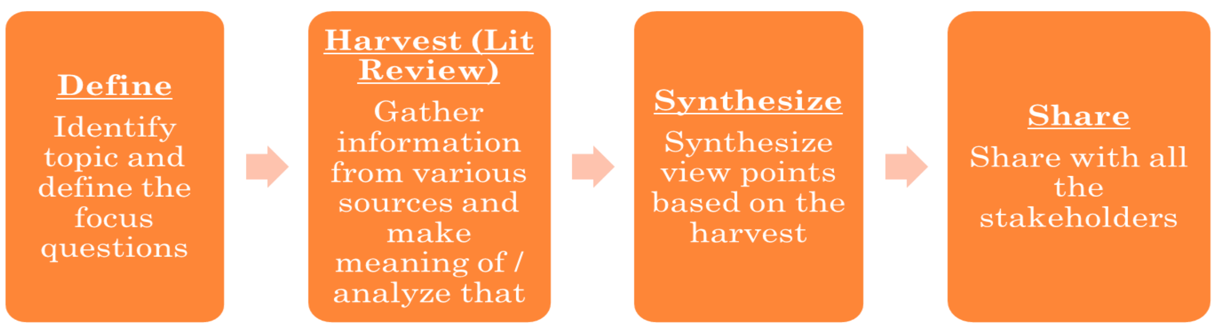

Figure 2: Process elements of the framework

Define: This consists of identifying *areas, sub areas, topics and focus questions*. Students describe *topics* that they liked the most and consider at least three topics before choosing the final one. Once they choose topics, they draft possible questions. They seek help of *experts*, *faculty mentors*, and peers to enhance the question set. The define phase ends with around five *focus questions*.

Harvest: In this phase, students gather information about the *focus questions* from books, journal papers, newspaper articles, etc. They contact the identified *experts* and interact with them in person, or over the Internet.

Some of them may carry out surveys to get insight into their topics. They are not mandated, but expected to meet their *faculty mentors* on a regular basis.

Synthesize: In this phase, students synthesize a coherent representation of their learning. They *synthesize* at information, knowledge, or wisdom levels. As an example, a history student may gather information about a regime and organize it chronologically (information synthesis), or analyze the reasons for the rise and the fall of the regime and coming up with a new perspective (knowledge synthesis), or perform such analysis for several fallen regimes to arrive at general principles behind such happenings (wisdom synthesis).

Share: The framework includes the phase to share learning with cluster peers and to evaluate students' performances. The framework has presentation templates for both mid-semester and end-semester examinations. Clusters are free to seek written reports, demonstration of live performances, or allow use of native languages for sharing. The framework also identifies attributes of great learners such as questioning, networking, self-belief, and expects students to assess themselves on those attributes, and prepare and execute plans to become great learners.

Execution

At the outset, the program director presented the framework to all faculty members and pursued them to enroll as mentors to different areas. The director explained the program background and execution process to students during orientation sessions. Subsequently, 313 students belonging to mechanical, production engineering, metallurgical, and civil engineering registered for the program and indicated their preferences for different areas. The paper analyses data of 273 students. All but fifteen students were allocated their top preferences. The fifteen students did not get their top preferences because their top areas were chosen by less than ten students and hence withdrawn. Those students were provided their next priority areas. The director also allocated faculty mentors to different areas.

Subsequently, the *faculty mentors* conducted meetings with their *area* students to arrive at various *sub areas*, *clusters* of about fifteen students each, a *faculty mentor* for each *cluster*, *topics*, *a student convener* and *co-convener,* and *external experts.*

The course did not include contact hours and was executed over Moodle (an online learning management system). We developed a departmental dashboard to observe students' progress through various stages like Moodle registration, topic definition, self-appraisal, and development plan preparation. Each *department* allocated graduate students as *coordinators,* who owned the department dashboards. *Faculty mentors* scheduled optional weekly meetings, which very few students attended.

The program director visited all the classes twice in the semester to discuss the course process with the students and to address questions and seek suggestions. In the first meeting, he explained the course communication process that was relying on emails and Moodle and urged them to follow the system. In the second meeting, he counselled more openness and subjectivity in their *focus questions* and encouraged them to expand their circle of *experts* beyond friends, relatives, and coaches.

The assessment method is shown in table 1. The mid-semester examination evaluated the choice of *topic* and *harvest, and sharing* skills; and the end- semester examination evaluated all aspects except choice of *topic*. Almost all the *clusters* used peer evaluation technique for both examinations. Some *faculty mentors* tried other methods such as, asking students to provide handwritten reports and demonstrate their skills, especially in the arts areas. Individual clusters were free to decide their evaluation methods, however, most of the clusters used peer evaluation method, which was recommended by the framework. The recommendation stemmed from the fact that the faculty members were not required to be experts in the areas and they did not have regular contact hours to do proper assessment. The cluster peers, on the other hands, tended to have better knowledge of the areas and efforts put in by their peers. We also recommended rubrics to enhance the quality of the peer ratings. Going by the feedback of the students and faculty mentors, the program was hugely successful [14].

Table 1: Assessment Method

Aspect	**Elements**	**Total Weightage**	**Mid-Sem**	**End-Sem**
Choice of topic	Novelty, relevance, reasoning, and process	5%	5%	0%
Harvest	Comprehensiveness and diversity of the study	25%	20%	5%
Synthesis	Originality of the viewpoints and value of the viewpoints	30%	0%	30%
Sharing	Methods of sharing and effectiveness of the sharing	30%	5%	25%
Becoming a great learner	Plan and result of the plan	10%	0%	10%
Total		**100%**	**30%**	**70%**

The following table lists sample areas, sub-areas, topics, and focus questions to provide an idea of the program.

Table 2: Sample studies

Area	Sub Area	Topic	Focus Question 1	Focus Question 2	Focus Question 3	Focus Question 4	Focus Question 5
Social Science	History	Partition of India	What was the situation before the partition of India?	What were the causes of the partition?	How did the partition take place?	What were the effects of the partition on India and Pakistan?	What were the feelings of citizens in India and Pakistan?
Sports	Other Sports	Rowing	What is the history of rowing?	What is the perfect rowing technique? Why?	Why rowing is popular in India compared to other countries?	What should we do to improve rowing in India?	What are the parameters for designing a rowing boat?
Defense	Sub-Area 3	War and Economics	What was the effect of the World war II on world economy?	What was the effect of Kargil war on Indian economy?	What was the effect of cold war and fall of USSR on world economy?	What was the effect of China war on Indian economy?	

Analysis of choice of the areas

The forthcoming sections present analysis of choices by determinants such as gender, academic performance, and learning styles. We had gender and academic performance data of 273 students and learning style data of 87 students. We have not come across similar experiments and could not compare our analysis with any other analyses.

Gender

Table 3 provides the choices by gender. While sports, business, and defense studies earned better patronage of male students; traditional feminine areas such as fine arts, performing arts and medicine earned better patronage of females. Using Minitab version 17, we ran a Chi-Square Test for Association and found Pearson p-value to be 0.000, indicating a statistically significant association between gender and the area choices.

Table 3: Choices by genders

Area->	Arts	Business	Defense Studies	Education	Env. Science	Medicine	Perf. Arts	Philosophy	Social Science	Sports
Female	19	8	5	2	6	8	17	3	6	2
Male	10	30	27	4	17	11	9	6	32	51
Total	29	38	32	6	23	19	26	9	38	53

We present the results of nominal logistic regression in table 4. We ran the regressions by choosing every area as a reference event. All the regressions models were valid (test that slopes are zero p values were less than 0.05). The table lists p values, and if they are lower than 0.05, adds odds ratios. The cells that have lower p-values and odds ratios are in yellow background. The odds ratio is a chance of a male student choosing that area as compared to a reference area. So, the chance of a male student choosing social science over sports is 0.21, and that of choosing arts over sports is as low as 0.02. Essentially, sports area was clearly favored by male students. Performing arts, medicine, and arts were favored less than social sciences by male students. Environmental science, defense, and business studies are favored by male students as compared to performing arts as well as defense studies was favored as compared to medicine. Environment science, defense and business studies are also favored by male students over arts.

Academic performance

Table 5 provides cumulative grade point averages (CGPA) of students by areas. The college follows 10-point grading system with A, B, C, D, F grades, which are equivalent to 10,8,6,4,0 points, respectively. Since the standard deviation can be considered equal (the ratio between the highest and the lowest deviation is less than 2), we ran ANOVA with Dunnett comparison with the null hypothesis that the CGPA means of all areas are equal. We could not reject the null hypothesis as the p value of the test was 0.91. We did not analyze academic performance by gender as we did not have enough data points for some areas for each gender.

Table 4: Logistic Regression Table (Each cell lists p value, and if it is lower than 0.05, lists odds ratio of male student choosing the area over the reference area)

Reference Area ->	Sports	Social Science	Philosophy	Perf Arts	Medicine	Environmental Science	Education	Defense	Business studies
Sports									
Social Science	0.06 & 0.21								
Philosophy	0.01 & 0.08	0.26							
Performing Arts	0.0 & 0.02	0.00 & 0.1	0.10						
Medicine	0.00 & 0.01	0.04 & 0.27	0.66	0.12					
Environmental Science	0.01 & 0.11	0.36	0.68	0.01 & 5.35	0.28				
Education	0.03 & 0.08	0.33	0.00 & 1.0	0.17	0.70	0.72			
Defense	0.07 & 0.21	0.99	0.27	0.00 & 9.82	0.05 & 3.78	0.37	0.34		
Business studies	0.02 & 0.15	0.59	0.44	0.00 & 7.82	0.10	0.65	0.51	0.6	
Arts	0.00 & 0.02	0.00 & 0.1	0.10	0.99	0.11	0.01 & 0.19	0.16	0.0 & 0.1	0.0 & 0.1

Table 5: Choices of areas based on academic performance (CGPA)

Area	**N**	**CGPA Mean**	**CGPA Std Deviation**
Arts	29	6.73	1.33
Business	38	6.76	1.52
Defense Studies	31	6.52	1.46
Education	6	6.92	0.85
Environmental Sciences	23	6.61	1.27
Medicine	19	7.09	1.18
Performing Arts	26	6.90	1.08
Philosophy	9	6.59	1.36
Social Sciences	37	6.47	1.60
Sports	52	6.71	1.38

Learning Style

Learning styles are relatively stable preferences that students have for ways to receive and process information. Close to a hundred different learning style models and associated instruments have been formulated. While there are many supporters and detractors of the styles [17-19], we agree with the observations of Felder [20] that the learning styles are useful descriptions of common behavior patterns. Felder, further, adds that they have been used frequently and successfully to help teachers design effective instruction, to help students better understand their own learning processes, and to help both teachers and students realize that not everyone is alike and the differences are often worth celebrating.

Index of Learning Styles (ILS)

The Felder-Soloman Index of Learning Styles is one of the most popular learning style instruments [21], especially in engineering education. It is based on Felder and Silverman's (1998) model and assesses preferences on four bipolar dimensions: Active-Reflective, Sensing-Intuitive, Visual-Verbal, and Sequential-Global. Active learners prefer doing things, particularly in groups. Reflective learners work better alone and spend some time thinking about the task before doing it. Sensing learners like facts, data, and experimentation and work well with details. Intuitive learners prefer ideas and theories, particularly when they get to grasp and generate new ideas. Verbal learners like to hear information and engage in discussion, particularly when they can speak and hear their own words. Visual learners like words, pictures, symbols, flow charts, diagrams, and reading books. Sequential learners prefer linear reasoning, step-by-step procedures, and material that comes to them in a steady stream. Global learners are strong integrators and synthesizers, making intuitive discoveries and connections to see the overall system or pattern [17]. Both innate personality traits and prior experiences may influence preferences on each of these scales.

The ILS scores indicate the strengths of an individual's preference for one category or the other on each of the four dimensions. The instrument is a 44-item questionnaire [21] that requires choosing one of two options that focuses on some aspect of learning. The choices result in a score of 1, 3, 5, 7, 9 or 11 for each of the preferred categories, with a 1 signifying a very slight preference for the category and an 11 a very strong one. The table lists average scores for the first preferences such as active preference score in active-reflective style, the other preference score (reflective) can be deducted by subtracting the first (active) preference score from 11.

Table 6: Choices of areas based on learning styles

	Total no of students	Active-Reflective	Sensing-Intuitive	Visual-Verbal	Sequential-Global
Arts	5	5.60	6.83	7.83	5.83
Business	11	5.00	5.73	7.45	5.73
Defense Studies	11	4.82	5.77	8.54	6.21
Education	4	5.75	6.00	8.33	4.67
Environmental Sciences	7	4.57	6.29	7.29	6.00
Medicine	7	5.14	5.57	8.00	6.14
Performing Arts	6	6.43	5.17	8.29	6.00
Social Sciences	19	5.32	6.18	7.71	6.50
Sports and Athletics	17	6.53	5.80	8.60	6.27

Table 6 provides averages of learning style preferences of them by liberal learning areas. We ran ANOVA test for each learning style preferences for all areas and found no statistically significant influence of the preferences in the area choices. The p values for active, sensing, visual and sequential preferences were, 0.13, 0.95, 0.78, and

0.68, respectively. Since some areas had less than 10 data points, we ran the test only for the areas (business, defense, social sciences, and sports) that had more than 10 data points. In case of active preference, we rejected the null hypothesis (active preferences for all four areas are equal) as p value was 0.028. Dunnett Multiple Comparisons with a Control indicated that the sports students had statistically higher preference for active learning style. For sensing, visual, and sequential styles, the p-value were 0.92, 0.27 and 0.79, respectively.

Concluding remarks

We developed the liberal learning program to fulfill the critical need of lifelong learning skills for engineering graduates. The paper analyzes students' learning area choices by gender, academic performance, and learning styles, and found the gender significantly impacting the area choices. Sports was hugely favored by male students, and arts and performing arts was favored by female students. Such clear polarization in area choices may indicate polarization in mindsets. It may have been creating challenging situations for educators as female students constitute around 30 % in the Indian engineering education system. This aspect requires further research. The academic performance did not significantly impact the area choices. The preferences for learning styles did not influence area choices, except the learners with active learning preferences appeared to favor sports. We had learning style preferences of only 87 students and require preferences from more students to increase confidence in our findings.

The program was well supported by faculty members, though, certain areas were not opted by any faculty members. The program director had to identify right faculty mentors as mentors for those areas. It will be worthwhile to study the choices of the faculty and their experience in detail. We require running the program at more institutions, possibly in different geographies, to validate findings of this study.

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