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Alternative Learning Approaches for Enhanced Students' Engagement in Engineering Courses

Sowmya Narayanan*, Munirathinam Adithan

VIT University, Vellore, Tamil Nadu, India

* Email: sowmya_grn@yahoo.co.in

Abstract

In the context of globalization and explosion of knowledge, engineering practices have to make a shift from mere problem solving towards more innovative solutions embedded in an array of social, economic, cultural and ethical issues. Innovation is a key differentiator in an increasingly global economy. The role of our engineering schools in providing human capital, necessary to meet future national needs, new orientation. Today's learners perceive learning as a "plug and play" experience. They want to plunge in and learn through participation and experimentation. Traditional approaches emphasize the presentation of information and consider learning as mere absorption of information. In contrast an effective student centered learning requires different perspectives from students and the teachers. The lecture dominated system encourages a passive learning environment, a highly compartmentalized curriculum and instills neither motivation nor skills for lifelong learning. It leaves no time for critical thinking, creative thinking and association with reality. Students today are active learners. The need of the hour is knowledge construction that can be achieved through active learning strategies like discussions, role play, group work, problem based learning, and project based learning. Students' engagement is seen as a successful indicator of classroom instruction. It depends on the level of academic challenge, active and collaborative learning, student-faculty interaction, enriching educational experiences and a supportive learning environment. This paper reports the various faculty training programmes organized in a university environment on the use of alternative learning approaches like discussions, role play and group work and its impact on students' engagement.

Keywords: Critical thinking; Creative thinking; Active learning; Students' engagement; Alternative learning approaches

1. Introduction

The University of Michigan, in their study "The Millennium Project1"(James's Duderstadt, 2008) have observed that the influence of globalization and knowledge explosion with evolving technologies has given a new meaning to the practice of engineering. There is a visible change in looking at the engineering discipline as premium subject of knowledge and practice. The implications of a new paradigm viz.; technology driven global economy are enormous. Engineering practice has to make a shift from problem solving towards more innovative solutions embedded in an array of social, environmental, cultural and ethical issues. The shift required is from traditional problem solving to innovation, research and industry relevance to seek solutions to societal problems. The role of our engineering schools to provide human capital necessary to meet future national needs faces particularly new challenges, said Clough and Duderstadt (2004) in the National Academy of Engineering deliberations.

According to a German study report (Continental A.G., 2006) the requirements of the 21st century engineers are considerable and diverse. They must be technically competent globally relevant, culturally aware, innovative, entrepreneurial and nimble, flexible enough and highly mobile (Continental A.G., 2006). Engineering education has to respond to incredible pace of intellectual change (e.g., from reductionism to complexity, from analysis to synthesis, from disciplinary to multidisciplinary and trans-disciplinary; and it has to reflect in its diversity, quality, and rigor the characteristics necessary to serve a 21st-century nation and the world, according to a study made by Carnegie foundation for the advancement of teaching (Sheppard, Sheri D. and William Sullivan, 2008).

Current engineering practice is highly sequential built upon a pyramid of prerequisites that can discourage student's fall of pace. There is little doubt that the current sequential approach to engineering education, in which the early years are dominated by science and mathematics courses with engineering content deferred to the upper-class years, discourages many capable students. Compounding this is the fragmentation of the current curriculum, consisting of highly specialized and generally unconnected and uncoordinated courses, whose

relationship to one another and to engineering education is rarely explained .(Schmitt and Roland, 2002.).

1.1 Beyond the technical knowledge:

CEO's survey in 1990's Business Higher Education Forum found that the qualities valued most highly in graduates beyond their technical knowledge or skills were:

- The ability to communicate well,
- A commitment to lifelong learning,
- The ability to adapt to an increasing diverse world,
- The ability not only to adapt to change but to naturally drive change.

An undergraduate engineering education should be viewed only as the initial launch for a career, designed to place the student in the lifelong orbit of learning. A more diversity is called for in the present and future engineering education. (Schmitt and Roland,2002.) Children raised in media rich, interactive environment level to think learn differently. They are physiologically different from us and their brains are wired differently. Learners today approach learning as a plug and play experience. They want to plunge in and learn through participation and experimentation.

Traditional approaches emphasize the presentation of information and define learning as its mere absorption and remembering. In this scheme, teaching excellence is perceived as sound academic knowledge, extensive content coverage and polished presentation skills. Excellence in learning is viewed as the flawless recall and summary of information. In contrast, a student centered classroom requires different perspectives from both instructors and students. Rather than merely covering the content, goals of instruction becomes the intentional intellectual development of the students. Students' of today are active learners. The need of the hour is knowledge construction and constructivist classroom (Virginia S. Lee 1999). This can be achieved only through use of active learning strategies such as role play, group work, discussion, case studies, project based learning, problem based learning, etc.

1.2 Knowledge Construction

Novak and Godwin. (1984) say that knowledge construction begins with current knowledge represented as concepts, principles and theories. Through a process of inquiry (formalized in academic disciplines as methods of inquiry), we transform empirical evidence (e.g., natural phenomena, historical events, human behavior) into revised and new knowledge structures. The six levels of Bloom's Taxonomy reflect not only the importance of acquiring information (i.e. knowledge) but also the intellectual process of application, analysis, synthesis and evaluation by which we transfer raw data into formalized knowledge structures. Utilizing the taxonomy during the instructional planning stage teachers can establish the ability to construct knowledge as a meaningful student learning outcome and embed its practice explicitly into the essential components of their courses (e.g. classroom instruction and evaluation can be integrated).

Leading scholars in the area of cognitive science and educational methodologies have concluded that it is essential that students need to be taught in a learning environment that enables them to acquire problem solving skills. The 21st century workplace does not need employees who have just mastered a particular body of information, instead it prefers to have liberally educated workforce who have mastered written and oral communication skills in addition to acquiring knowledge in their chosen discipline. (Sage 1998; Senge 1990; Sims 1995); (Mysore Narayanan, 2009).

As a recent NSF Workshop on engineering education put it: "The ubiquitous lecture is the bane of true learning, especially in observation-based, hands-on fields such as engineering. The lecture-dominated system encourages a passive learning environment, a highly compartmentalized (one lecture- 50 minutes/1 hour capsule sized) curriculum, and worst of all, instills neither the motivation nor the skills for life-long learning. Engineering education should move away from the current dominance of classroom based pedagogy to more active learning approaches that engage problem-solving skills and team building.

A research undertaken by Memphis State University (Drouin L.E., 1992) suggested that undergraduate engineering programmes have been criticized for not producing engineers who can think critically. Rote memorization, perhaps useful in some educational environments can be harmful where skills such as understanding, comprehension and application are critical to the success of the organization. Unfortunately the lecture and homework routine in an engineering curriculum leaves no time for reflection, critical and creative thinking and association. Fowler D.A. (2003) has found in an impact study of freshman engineering students'

performance that having a deep approach to learning had a positive influence on student retention in engineering programmes.

2.0 Students'engagement:

R.L. Kirby (2010) explains that students' involvement with their classes and courses ranges from being fully engaged to being almost completely distant from the experience: from being active to being passive in their own learning. That learning is on a continuous spectrum from waiting to be taught to using the instructional resources developed by the professor and other range of learning material in search of answers. In this process students are fully involved and are self regulating.

2.1 Fallacy of measuring success by individual triumph:

"In our traditional educational system, we teach students to perform on their own. Tests are given to rank how well one does against all others. He or she is being graded against all those other students: and high grades are usually a major influence in attracting high entry level job offers. Unfortunately the consequence of learning in a hierarchical "play it back to the professor" model (William Y. O'Connor,k1999), include narrowing of vision; working primarily to satisfy a professor in order to achieve a good grade and measuring success by individual triumphs only. In reality, solving a real engineering or societal problem involves group task and team work and in many cases problem itself is not structured or well defined. Merely providing the course content is no longer enough, we must offer it in ways that support the work style needed for success in future world of work.

Thus, there is a need for engineering courses and technical universities to advocate a self regulated model which incorporates the following in the curriculum and its implementation and evaluation.

- Setting appropriate goals which guide their studies.
- Developing and using appropriate knowledge, skills and attitudes to direct these studies, and.
- Consciously selecting learning strategies appropriate to the task at hand.

In a study on the employability skills of engineering students in India, made by WIPRO, Talent Transformation (Wipro India Report) the challenge is not supply of talent but that of talent meets the needs of the corporate world. It is not about having a good curriculum or good faculty, what is then the employability enigma. If the students augment their skills in a few areas desired by the industry and society employability in the country can be enhanced.

Hence industry, businesses and society will need employees who can

- Respond flexibly to challenges with novel ideas.
- Take sense out of contradictory messages.
- Identify the important element in a situation which calls for further study.
- Find similarities even when differences separate them and
- Draw distinction, even when similarities link ideas together.

2.2 Higher Order Thinking Skills (HOTS)

The work related attributes cited earlier all call for higher order thinking skills. Students who are motivated are engaged and they do better in the learning of HOTS than students whose goals (to get high marks) are narrower. Motivation is the key; among the various needs to be satisfied, the need to comprehend has the greatest effect on engagement with the Students University as specifically the tasks that the learners are required to do. Students who effectively learn in their courses are deeply engaged (Kirby R.L., 2010)] Students, who in turn will be more likely to meet their goals, more likely to enjoy their courses and more likely to feel confidence that they can apply learning to future situations. They would learn at a higher order of thinking and will be able to select appropriate methods to deal with the problem. Critical analysis becomes an integrated part of the learning process.

2.3 Benjamin Bloom's Taxonomy of Educational Objectives.

Benjamin Bloom in 1956 proposed a Taxonomy of Learning Objectives of the Cognitive Domain. This work has been used by researchers, teachers, curriculum planners and examiners, administrators and to a certain extent at all levels of education (Anderson and Sosnaik, 1994). The objectives are placed in a hierarchy starting from Knowledge to Evaluation. The first three levels namely knowledge, comprehension and application are generally known as LOTS (Lower Order Thinking skills) while, analysis, synthesis and evaluation are termed

HOTS (Higher Order Thinking Skills). . However, according to the authors, in engineering education, the level "application" needs to be positioned in HOTS since students of engineering and technology are expected to know the engineering and technological applications of the various theories, principles and concepts that they learn while studying the various subjects. There is a need to sensitize the engineering faculty on this critical aspect. The taxonomy is hierarchical; each level is subsumed by the higher levels. In other words, a student working at the application level has also mastered the material at the knowledge and comprehension level. (U.W, Teaching Academy, 2003).

"Understanding by design" causes students to identify the important concepts, to see the big picture and to reflect on their own learning. If the student does that then the student is involved in active learning. Active learning is a process of engagement by doing: it is experiential learning and working towards the resolution of an issue or solving of a problem, or developing a response to a question that may not have a right or wrong answer. Active learning encourages such reflection by providing support to enable people to learn from challenges as well as from themselves and the process itself. The benefits of learning are; that the knowledge is more likely to be transferred to other situation and participants will then know how they know, how they learnt it. Dr Chris Argyris has categorized this as double loop learning (R.L. Kirby, 2010).

2.4 Project based Learning (PBL)

PBL is active learning designed that takes the student to the very top of Blooms Taxonomy. It works well for fully engaged students who can handle the discovery and use of resources to solve a problem. Extensive research on how the human brain learns indicates that diverse teaching methods enhances critical thinking skills, long term retention of information and students and sustains continued interest in learning further. Despite what is now vast body of research about how people learn and which teaching methods are most effective at transmitting knowledge and building critical thinking skills, most engineering courses have neither the time nor the incentives for the engineering faculty to find, read and evaluate the best and alternative teaching methods. Most engineering teachers use methods by which they themselves were taught. What we require now is evidence based teaching practices suitable for a particular category of learners.

VIT University, Vellore is in the forefront of bringing innovation in the teaching-learning process. A variety of training programmes for the engineering faculty are being organized which uses techniques for enhancing the critical and creative thinking skills of the students. Faculty is trained in the use of alternate learning approaches that affect the way in which student's process information. Students are no longer passive learners in the classes. They are actively engaged in the classes. Active learning training is given to the faculty which has created excitement among the learners in the classroom. College teaching and lecturing have been so long associated that when one pictures a college professor in a classroom, he almost inevitably pictures him as lecturing (R.L. Kirby, 2010).

Incorporating active learning strategies into daily classroom instructions should be made integral to the teaching process. To help in this pursuit, through the faculty development/training programmes VIT engages the faculty in specific, practical, teaching strategies designed to model the use of active learning in the classroom.

A research comparing lecture versus discussion techniques has concluded that in those experiments involving measures of retention of information after the end of a course, measures of problem solving, change in thinking attitude or motivation for further learning tend to show differences favoring discussion methods over lecture (McKeachie,W.J., Pintrich,P.R., Lin, Y.G., & Smith, D.A.,1987).

The authors have conceptualized various themes of the training programmes required for VIT faculty. Such training programmes offered to the faculty is given below.

3.0 Bloom's Taxonomy of Educational Objectives:

Objectives of the training: To familiarize the faculty with various levels in Blooms' Taxonomy of educational objectives; elucidate the importance of use of higher order thinking skills (HOTS) questions during classroom instructions and in testing and evaluation; to analyze the question papers set by faculty with respect to HOTS.

Methodology Adopted: Discussion method was used to train faculty in Bloom's Taxonomy. Various exercises that bring out the 'cognitive complexity' of Bloom's hierarchy were discussed. Faculty frame questions using HOTS and also assesses their own questions using HOTS. Opportunities to present innovative methods of instruction were given to faculty to enhance critical thinking and creative thinking amongst the students. Quizzes and puzzles were also used to reinforce various levels of Bloom's Taxonomy. (ANNEXURE 1)

3.1 Multiple Intelligence(MI) :

Objectives of the training: To introduce the theory of Multiple Intelligences proposed by Howard Gardner; understand the implications of the use of MI theory in the Teaching Learning process in respect of the courses taught by the faculty.

Methodology Adopted: An awareness of the theory of Multiple Intelligences is brought about through a lecture supplemented by videos. Faculty is given the MI test to find out for themselves their own intelligence profile. The faculty is given instructions as to how to administer the MI test for their students and to interpret the results. During the training various exercises and discussion methods bring forth the innovative ways of incorporating MI in the Teaching Learning process. Videos of classroom activities of faculty who have used the MI successfully are shown to the trainee faculty. Brainstorming among the faculty helps in creating personalized and innovative assignments for the students to cater to different types of students in the classroom. Each intelligence is thoroughly explained either through a video or an activity or a puzzle.

3.2 Mind Mapping:

Objectives of the training: To familiarize the faculty with the concept of Mind Mapping concept as proposed by Tony Buzan; to train the faculty in the use of mind maps to enhance the effectiveness of their classroom instructions.

Methodology Adopted: Faculty are taken through a lecture on Mind Mapping giving examples. Subsequently faculty trainees have been asked to choose a topic from their subject and are asked to draw mind maps for the various topics and sub-topics as per the curriculum. This gives a practical understanding of the use of mind maps and how this enables them to understand the various topics in the course curriculum in an integrated way and how the body of knowledge is built. Through group discussions and presentations faculty demonstrate their understanding of mind maps and pick up ideas to use them effectively to plan their classroom instruction.

3.3 Alternative Learning Approaches:

Objectives of the training: To train the faculty on the use of alternate approaches to learn such as quizzes, role plays, puzzles, brainstorming.

Methodology Adopted: Faculty are given an array of alternative learning approaches, instructions and examples concerning role play, quizzes, brainstorming, group discussion. Various strategies are explained to the faculty to use them effectively in the teaching learning process. Faculty is then asked to demonstrate a few of them with respect to their subjects/topics. Faculty creates sample quizzes, analogies, puzzles and presents them to their colleagues elicit comments and feedback and fine tune them. Various subject specific role plays, quizzes, group discussions and animations used by different faculty across various universities abroad are presented through videos to faculty to motivate them and to facilitate the faculty in bringing innovations in their classrooms too.

Thus the faculty development programmes organized by Academic Staff College (ASC) at VIT University, Vellore stimulate the faculty thinking to be creative in their teaching learning process. Also ASC provides a platform where faculty from different engineering disciplines interacts and experiment their strategies with colleagues. This help them fine tune their ways which would further be refined and offered to the students. Thus Faculty Development Programmes organized pave the way for faculty to test their ideas and implement them. This helps in making the faculty to gain confidence in improvising methods of teaching and successfully implementing alternate approaches to learning in the classroom.

The experiential learning the faculty and students acquired in the new learning approaches adopted are narrated below:

Name of the Faculty: Senthil Jayavel

Topic: Operating System

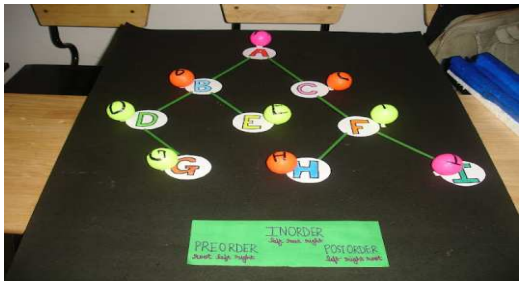
3.4 Innovative Learning Approaches:

"My thoughts on using alternate learning approaches (LA) in the classroom. The narration would touch upon my professional as well as personal experiences.

Students often expect change in teaching learning methodology. Routine role plays or animations or power points make them less interesting. To bring out new methodology and to create the eagerness/expectation that what interesting thing will happen in today's class is the challenging task. To capture their attention, I feel I need to keep on focusing on new methodologies.

In reality, students are in fact more innovative than a faculty. I group them and inform them to bring new teaching-learning methodology and it will be rewarded. This makes things very easy; they bring awesome

methods for explanations, sometime class room becomes like a TV Channels with a variety of shows.



Topic/Lesson: Tree Traversal Model
LA adopted: Demonstration using models

Topic Taught: Semaphore
LA adopted: Role Play using characters from the Indian epic Mahabharatha

LA adopted - Role Play

3.5 “Sharing and Creating Interest…”

“I always share my experiences of whatever I do with my colleagues who handle the same course. As a part of coursework I usually have a term-end exhibition showcasing all what we have done and how we have done throughout the semester. I invite my colleagues to see and give suggestions for improvement. Some get inspired and they like to try it. Use of mobile apps and tablets to teach in the class is inspired by most of my faculty friends as it reduces lot of typing and documentation works.

It’s the human tendency to get Vitamin-Appreciation now and then to energize ourselves. This vitamin is from fellow colleagues which enhances interest generated in the classroom. Whenever my friends or students come with a new idea, I appreciate them for their suggestions.”

Students show casing technical concepts using models and colleagues visualizing it.

3.6 “Miles to go before I sleep”

VIT University, under newly introduced faculty empowerment programmes courses can be offered by the faculty, where the faculty is free to set his own coursework. I take my courses under Project Based Learning. I put more emphasis on the projects carried out by the students rather than the written exams. Project into product is always the aim. I took Operating System course where students are motivated to come out with android apps and those apps are in the android market now. I believe entrepreneurs are not born, they are even created and a teacher has a greater role towards it. I don’t want to be like a Professor who taught Fred Smith, founder of Fedex,

who said that his Fedex project is not worth and given him a C Grade. I know I am not the almighty and I know that my students dream for something, let me at first support him to bring it to reality rather than saying it is impossible in the moment he declares the idea. If it is even impossible let him realize it, because that experience he is going to gain is invaluable.

Querying and giving suggestions for innovative projects and students bringing out their talents (Products).

1. Term-End Class Exhibition showcasing all the activities done in the class in the whole term (semester) is a grand class expo. It comprises of models, projects, review papers, posters, videos of the role plays and animations carried out in the entire semester.

A welcome board for the term end exhibition

2. Use of Ipad apps to explain the concepts in class, for taking attendance, using it to write the notes and send them to the students through email.
3. Creation of a standard course websites and trying to Benchmark it.

“Intel considered our website as one of the best for reference materials for Parallel Processing Data Structures.”

4. Discussing the students work and checking the feasibility and helping them for filing patents/publications in the journal.

Decorating the walls with research posters to make the classes interesting and interactive

4.0 Students' Perception:

Students' perceptions are summarized below:

"Most of the students feel the method of learning doesn't pressurize them and they feel their participation in the class. They appreciate the use of a known concept to explain unknown makes them easy to remember. They feel the new learning methods help them to improve their communication silks, inter and intra personal silks, team work etc. They even feel their confidence level is getting raised by the active learning environment. Project based learning makes them more experienced and they feel very excited when they come out with their own idea into a marketable product.

Changes cannot be accepted by all students; some feel they want to be traditional. They feel why I bring all this role plays, projects, debates etc and disturb them. To bring some reserved type of students to the activity like role play is really a challenging task. They enjoy when others do but they don't want to be in public. It takes lot of effort to bring them into the picture. Forcing them sometime leads to a negative feedback. To overcome that I ask what they like to do and sometimes I need to explore their liking also to make them to come forward with that and then mould them with appreciation and encouragement to come out with what I want."

Model for 8 Queens Problem

4.1 Personal front

"The Faculty Development Programmes emphasizing new teaching-learning approaches have created a respect, passion and a special place for me among the students. In VIT, students select their faculty for their courses under fully flexible credit system (FFCS). I feel so happy when students come and say that they have very tough competition to get me as their faculty during course registration, even though I extract lot of work from them.

Some of them personally meet along with their parents to get their career ideas. Even some times personal issues are shared. They started seeing me as one among them with respect and love. Students like to have me as their final semester project guides and as mentors for any competitions/events organized by MNCs'. They feel I am there always for them to guide, I feel proud about that. Some students though they have not registered under me for the particular course they come and ask for the projects and they take part in the exhibitions and workshops I organize voluntarily".

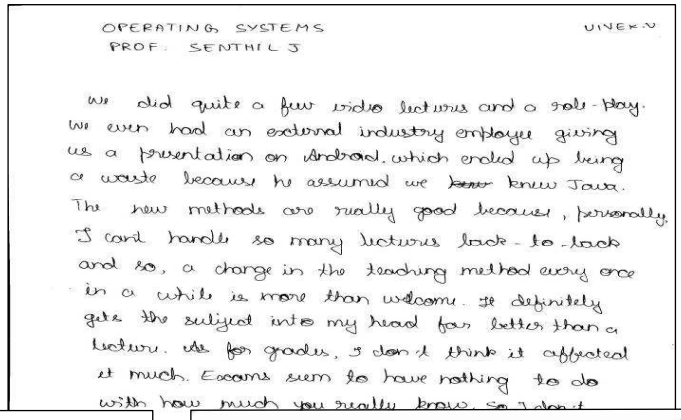
My Active learning class

Students Conducting Quiz

"I feel the confidence in my profession. Sessions on alternate learning approaches taught me that a teacher is more of a facilitator. Since I facilitate I don't have more burden. I always have lot of student visitors for my cabin sharing their ideas and creations which keeps me busy. I never get bored, may be vacation days for the students I consider as the dull days in the university. I feel as if I am in my college days and I feel my age is in between 18 – 21 always. The joy with my student team when doing a project or organizing an event, there is no words I find to explain them. I feel proud to say that I learn lot while teaching them, how to learn. The major difference is I don't hold everything now I give them the fair chance to express."

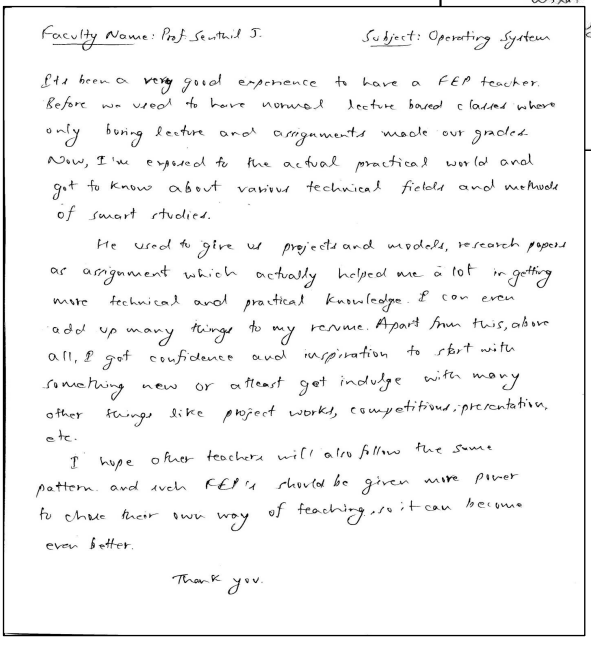
4.2 Student Feedback:

Students' who have experienced the alternate learning approaches in my class have given their feedback and their thoughts are reproduced below:



OPERATING SYSTEMS
PROF. SENTHIL J

We did quite a few video lectures and a role-play. We even had an external industry employee giving us a presentation on Android, which ended up being a waste because he assumed we ~~knew~~ knew Java. The new methods are really good because, personally, I can't handle so many lectures back-to-back and so, a change in the teaching method every once in a while is more than welcome. It definitely gets the subject into my head far better than a lecture. As for grades, I don't think it affected it much. Exams seem to have nothing to do with how much you really know. So I don't



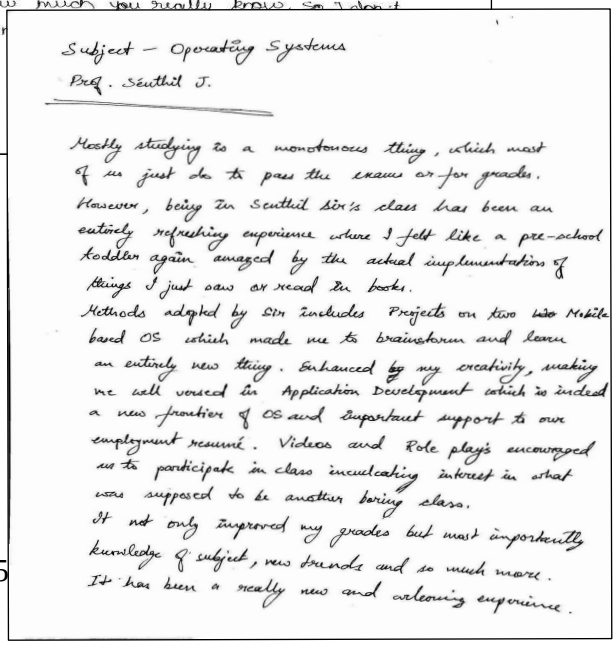
Faculty Name: Prof Senthil J. Subject: Operating System

It's been a very good experience to have a FEP teacher. Before we used to have normal lecture based classes where only boring lecture and assignments made our grades. Now, I've exposed to the actual practical world and got to know about various technical fields and methods of smart studies.

He used to give us projects and models, research papers as assignment which actually helped me a lot in getting more technical and practical knowledge. I can even add up many things to my resume. Apart from this, above all, I got confidence and inspiration to start with something new or atleast get indulge with many other things like project works, competitions, presentation, etc.

I hope other teachers will also follow the same pattern and such FEP's should be given more power to choose their own way of teaching, so it can become even better.

Thank you.



Subject – Operating Systems
Prof. Senthil J.

Mostly studying is a monotonous thing, which most of us just do to pass the exams or for grades. However, being in Senthil Sir's class has been an entirely refreshing experience where I felt like a pre-school toddler again amazed by the actual implementations of things I just saw or read in books.
Methods adopted by Sir includes Projects on two new Mobile based OS which made me to brainstorm and learn an entirely new thing. Enhanced by my creativity, making me well versed in Application Development which is indeed a new frontier of OS and important support to our employment resume'. Videos and Role play's encouraged us to participate in class inculcating interest in what was supposed to be another boring class.
It not only improved my grades but most importantly knowledge of subject, new friends and so much more.
It has been a really new and welcoming experience.

5.0 Conclusions:

Traditional instruction methods, predominantly lecture based have failed to address the knowledge requirements of a rapidly expanding technological society. They only create a passive learning environment where the student is subjected to shallow learning. Deeper learning requires a learner to think critically, creatively and be a problem solver. Skilful teaching requires that faculty become knowledgeable about the ways and strategies promoting active learning that have been successfully used across the disciplines.

Further, each faculty member should engage in self-reflection, exploring his or her personal willingness to experiment with alternative approaches to instruction. Discussion in class is one of the most common and effective means/strategies of promoting active learning with good reason. If the objectives of a course are to promote long-term retention of information, to motivate students toward further learning, to allow students to apply information in new settings, or to develop students' thinking skills, then discussion in the class is preferable to lecture method. Active learning pedagogies worthy of instructors' use include quiz, cooperative learning, debates, discussion, role play and simulation, and peer teaching.

An attempt has been made to expose the engineering faculty to a variety of new and alternate learning approaches. This brings in the transition from teacher centric to learner centric education, i.e. a paradigm shift from teaching to learning. The experiences of faculty using the alternate mode of learning and its impact on the students learning process are represented here.

Feedback from students clearly indicates their appreciation for the new methods and their increased involvement and engagement in the class. Hence alternate methods of instructions are here to stay and revolutionize the teaching learning process.

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Subject : _____ _____

School of Electrical Engineering

Analysis of Question Paper With respect of Bloom's Taxonomy

Date :			(numbers indicate the marks allotted to the question)			
	LOTS		**(Higher Order Thinking Skills (HOTS)**			
Test Item/ Question No	**Knowledge**	**Comprehension**	**Application ***	**Analysis**	**Synthesis**	**Evaluation / Judgement**
1						
2						
3						
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Total :						
		Actual		**Desirable**		
Know + Comp =		%		20 - 25%.....30% (max)		
App + Ana + Syn + Eva =		%		70 - 75%		

* For the analysis, "Application" level is considered as an Higher Order Thinking Skill. In Engineering education, students study many principles rules laws and equations and it is desirable that they also know and learn their practical applications in different areas of engineering and technology.