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Active Learning Strategies In Engineering Education

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Abstract: *Teaching Pedagogy is a new learning strategy that enhances the students existing knowledge, beliefs and skills. It develops student's capacity to value different perspectives and builds their sense of agency with diverse opportunities for learning; provide students with an equitable chance for success. With this pedagogical approach, students can synthesize new understanding from prior learning and new information. So, to improve the academic research in students to take a broad approach in their studies, while also maintaining an awareness of the quality and rigor of their academics. Teachers adopting more expansive and imaginative approaches like collaborative learning, flipped classroom, One minute paper, Fun do Thursday, Think aloud pair problem solving to investigating technology and education to develop new innovations from students.*

Key Words: *Active Learning, Collaborative Learning, Cooperating learning.*

1. IMPORTANCE OF ENGINEERING:

Nearly everything in people's daily lives is an engineered object or system, often referred to as technology. The cup used for coffee or soup, cell phones, logistics systems that distribute food to supermarkets, trucks that bring it there, buses and trains that convey people to work, houses, apartments, and office buildings, and the environmental systems that make these places habitable all are engineered. In sum, people all over the world are dependent on engineering for myriad aspects of their quality of life.

Yet many people have no idea how technology is engineered and developed or how it works. Only 15 to 20 years ago, cell phones were heavy and limited to audio calls. Then, almost overnight it seemed, they could do practically anything, and today smartphones are ubiquitous. Refugees fleeing civil unrest buy them to use the GPS map app.

Of course, it is not essential to know how the operating system of a cell phone works. It is useful, however, for people to have at least a sense of some of the elements necessary to the development of technology, so they can appreciate the array of opportunities for participating in this development and contributing meaningfully to the world around them.

The system of innovation and technology development is diverse and complex, involving research and development organizations in the public and private domains, government funding for basic research, universities, the patent system, the availability of capital, marketing, channels of distribution and perhaps the most critical element, people. People generate the ideas for innovation and development, and frequently those people are engineers. Engineers are essential to the creation of new technology, which has been a large contributor to US economic growth over the past century. Thus it is of national importance that the population of engineers available to the labour force is continually replenished and updated to thrive amid changes in technology and the global marketplace. That supply of engineers depends on a system that can be called the engineering education -to- workforce pathway.

The Greatest Engineering Achievements of the 20th Century

In 2003 the National Academy of Engineering published A Century of Innovation: Twenty Engineering Achievements That Transformed Our Lives, which chronicled the development and impact of what the Academy characterized as the top 20 engineering achievements of the 20th century.

The ranked achievements were:

1.	Electrification	11.	Highways
2.	Automobile	12.	Spacecraft
3.	Airplane	13.	Internet
4.	Water supply and distribution	14.	Imaging
5.	Electronics	15.	Household appliances
6.	Radio and television	16.	Health technologies
7.	Agricultural mechanization	17.	Petroleum and petrochemical technologies

8.	Computers	18.	Laser and fiber optics
9.	Telephone	19.	Nuclear technologies
10.	Air conditioning and refrigeration	20.	High-performance materials

TABLE I: Engineering Achievements of the 20th century

Growth in Engineering Degrees Awarded Annually

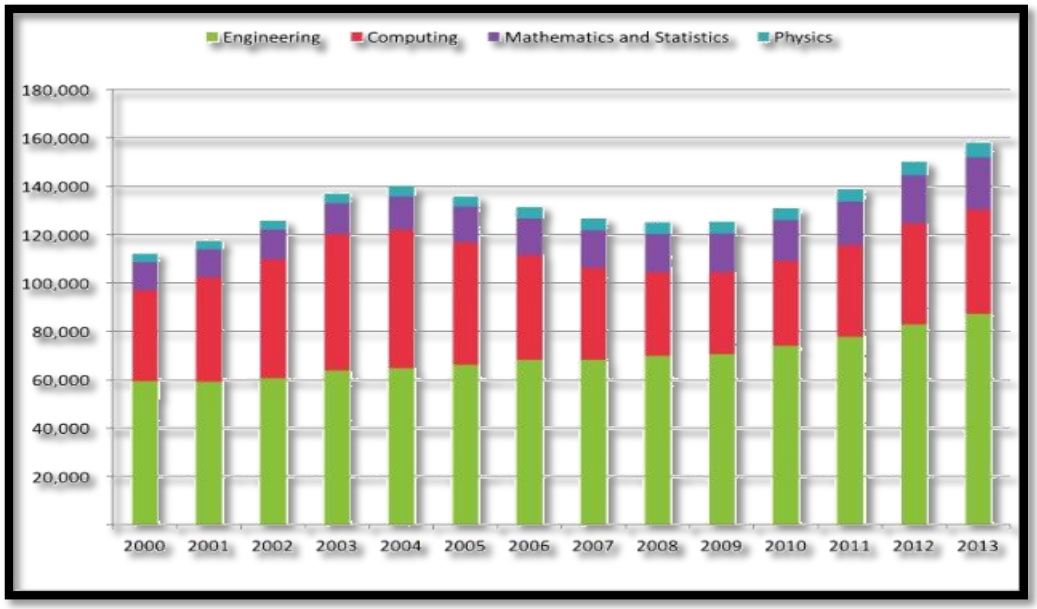

Figure 1.1 Growth of Engineering Degrees awarded Anually

From 2000 to 2013 the number of engineering degrees awarded each year increased 46 percent more rapidly than the rate of all US bachelor's degrees (41 percent). The number of engineering master's degrees awarded annually grew 69 percent over the same period, and that of doctoral degrees 58 percent. By comparison, the number of degrees awarded annually in the related fields of mathematics/statistics and physics rose even more rapidly over the 13-year period, roughly 80 percent each, but from a much smaller base, accounting for only 21,000 and 6,000 degrees awarded in 2013 respectively. In contrast, the annual production of computing BS degrees grew only 15 percent over the period; rapid growth from 2000 to 2004 was followed by a 6-year decline before reversing the downward trend in 2011 to end in 2013 with 43,000 degrees awarded.

2. Career Pathways Of Engineering Graduates:

It is revealed that there is considerable mobility across engineering, engineering-proximate, and non-engineering occupations.

Working in engineering:

1)Moving from a non-engineering or engineering-proximate to an engineering occupation
2)Moving from an engineering to an engineering-proximate or non-engineering occupation
3)Starting in engineering management
4)Starting in an engineering-related occupation
5)Starting in a non-S&E occupation

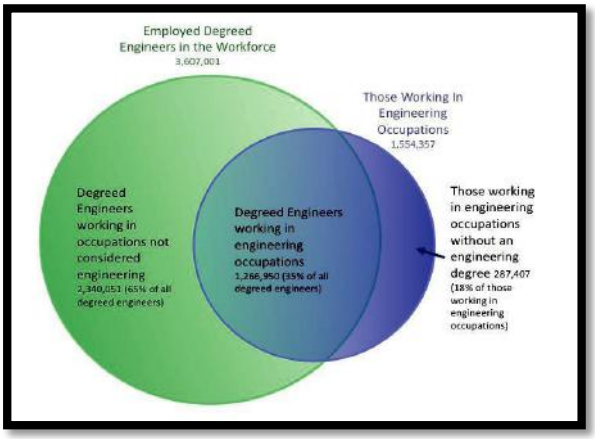

Figure 2.1 Career paths of Engineering graduates

3. APPROACHES TO DEVELOP NEW SKILLS FOR ENGINEERS IN THEIR STUDY THROUGH ACTIVE LEARNING STRATEGIES:

I have divided my teaching philosophy into three parts. One I will be sharing last two years of my sincere efforts to helps students to become employable graduate and second my present challenges I'm facing and third my plans to over my challenges and set new targets to help students.

My vision being an educator to transform myself from teacher to trainer. Teacher make students graduate, and trainer makes students employable graduate. we believe doing engineering rather than studying engineering.

Best way to make students employable graduate engage students in practical learning by establishing new centers or laboratory on cutting edge technologies where students work along with trained faculties. In this way, we can ensure students will not only become employable graduate by also improve communication skills, hardware, coding skills, working in a team, peer learning, leadership qualities, how to handle failure, how to complete work in the given time, self-learning, etc.

Combined with evolving core technical skill requirements, the need to provide graduates with enhanced professional skills may appear to some a daunting proposition for engineering educators. The engineering curriculum is already tightly defined by required courses, and faculty, in general, have few resources and little time for learning and incorporating new material. Engineering enrolments are increasing, putting more demands on faculty and institutional resources.

Engineering classrooms are ideal laboratories for developing new approaches to learning. For example, in one approach, the Conceive-Design-Implement-Operate (CDIO) Initiative, collaborators across several institutions have developed and shared resources that prompt change in engineering education. Specifically, educators stress both fundamental engineering science concepts and personal/interpersonal skills, focus on retaining students, engage with industry, collaborate, and use evidence-based teaching practices. CDIO aims to educate students who are able to:

1. Master a deeper working knowledge of technical fundamentals,
2. Lead in the creation and operation of new products, processes, and systems, and
3. Understand the importance and strategic impact of research and technological development on society

The expanding foundations of theoretical knowledge are as essential asever, but technological and pedagogical breakthroughs are introducing new tools (e.g., dynamic simulations) and mechanisms (e.g., student-centered teaching techniques) for the delivery of academic content, and incoming generations of students are “digital natives.” Faculty can take advantage of their students’ technological capability while embracing student-centered approaches designed to impart the skills and attributes needed in the workplaces of today and tomorrow With this convergence of trends, now is the time for teaching to change.

The following section addresses several promising directions in engineering education at the postsecondary level that are responsive to the demand for graduates with both technical and professional skills such as creativity, leadership, entrepreneurship, and the ability to work in an interdisciplinary environment. The interventions build on a growing knowledge of how people learn and teach engineering. Engineering education research on topics such as student learning, engagement, and motivation has informed both classroom and extracurricular interventions. In addition, research in educational, learning, and social and behavioural sciences has helped engineering faculty develop and use more engaging activities, implement inquiry activities that combine instruction and assessment, and include student learning outcomes and educational objectives in curriculum. Participation in engaging and challenging activities supports all students as they determine the implications of course material. In addition, the educational approaches described below have been shown to improve diversity by better engaging women, underrepresented minority, and other marginalized students.

Advances in understanding of how people learn engineering, corresponding evidence based innovations in pedagogy and technological tools for the education of engineers, and the digital fluency of incoming generations of students are all creating new needs and opportunities for engineering education to adapt. These curricular changes both improve graduates’ professional and lifelong learning skills and attract more women and underrepresented minorities to the field.

Some of the principal instructional technologies and their applications have been:

A. Traditional Students in a Non Traditional Class:

A few students in my classroom who were sitting in the last bench are the trouble makers to all the faculties, they never used to involve in any of the subject class.I was worried initially about them but later I used to call that students on to the dice in between the lecture and asked them to explain what I was teaching previously. If they were unable to explain I asked them to sit in the first bench and repeated the class happened previosly. After similar situations like this transformation happened in that students they used to listen to the class and started actively participating in the exercises conducted in that class. I also said some motivational facts about the great people who achieved success with their own self learning. I used to give certain tasks to complete on their own by research and study.By this activity students gained knowledge and realized they can achieve anything on their own.

B. Faculty Concerns:

In my previous classes I used to follow the traditional approach which includes Lecturing,Designing Assignments and Grades where it is a kind of passive learning later I converted it into the Active learning by conducting activities in between my lecture and assigning students certain tasks to work on their own, and now I asked students to maintain a running notes where students will be listening to the class and writing the important points which they understood in their own words and I said they will given with the assignment marks based on their running notes. I observed this worked very well and all the students were listening to the class for the reason of the running notes and In the 50 mins of my lecture first 5 mins I used to ask the questions on the previous class and then gave summary of the previous class and continued with this lecture, by doing this students will have the interconnection of the topics and learn easily and after 20 mins I used to conduct a small exercise to overcome the boredom of the students. At the end of each module of the subject, I used to give complete notes handout of that module and asses on that handout. By doing the assement of the handout material provided all the students used to go through the handout.

C. When I tried Active learning in my class ,Many of the students hated it. Some refused to cooperate and their not interested approch was clear to me:

Intially When I conducted the activities like flipped classroom and think pair share, I observed that all the people were not involved in the activity and their attitude of disinterest was shown clearly to me. I handled this by announcing that they will be provided with the grade points if they were involving actively in the activities and also they will be given a award of the best team member who involved in active participation as well as helping others to work and making them involve.

D. I am having a particularly hardtime getting my students to work in teams:

I motivated the students by saying few situation were teamwork did miracles in solving critical problems and its contribution in the nation building.I also explained the students that once they are out of the collge they have to work in the teams irrespective of their differences, I made students to realize the importance of teamwork. I used to assign them individually working in an teams and made the announcement to the students that you will be graded individually. This two simple things made me to successful conduction of the activities were teams are involved.

E. Active Learning Strategy

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F. Flipped classroom:

I created Analog and Digital Electronics whats app group. Every day at 7:00 PM I will post one 5 to 10 mins video related to my next class topic. I used unique approach class "Mid night challenge" . I have informed students before night 12 o clock all students should send me thumbs up in group ones they have watched that video. Every day before starting my lecture I will ask in class how many students watched video which I have posted last day in the group and conduct think pair share activity. In case any students who could not able to watch video will get opportunity to know what I am about to deliver in class.

Observation: first a few days I could see only 70 to 80 % of students responded in group and now after 2 months I can see almost 90 to 95 % of students are responding in group every day. This not only helped me to set base for my next class but also helped students those who are absent in the class. This helped me a lot in time management and involved academically week students in the class.

G. Think aloud pair problem solving:

I choosed Combination Logic Circuit Designing which is one of the important topic in Digital system Designing. I implemented TAPPS activity, By this activity, this concept can be delivered in an better way to the students because this topic combinational Logic designing involves combination of reasoning, theory, practice, and implementation. They can actively participate, Feel confident and can learn the topic without difficulty by this activity.

Before conducting this activity, I explained the Analysis and Design Procedure which is required to solve any Combinational Logic Design problem and I explained few problems and their solutions using the analysis and design procedure steps, once I felt that students are confident with the topic and are able to solve the problems, I conducted this activity.

The time allotted for this activity 7-8 Minutes
Students pairing up according to their roll no's as two members each pair and designation of one Explainer and one questioner in each pair – 1 Min
Explainer and questioner to analyse the problem given – 1 Min
Explainers to explain the Problem solution to the other partner – 1-2 Mins
Questioners ask questions to explainer if the solution is unclear and at the same time takes the notes of the solution provided by the explainer – 2 Mins
Pairs to explain the solution to all their peers – 2 Mins
Explainer and questioner will interchange their roles and proceed with the next question

Based on the solutions provided by the pair, If I get the correct solution and clear explanation by the pair, I can assume that all the students are confident with the Topic and If I get maximum correct solutions from all the pairs, I will assume that My activity worked successfully.

I choose this TAPPS activity for this topic because students can feel confident in this topic combinational Logic Designing, if they solve multiple designing problems by brainstorming and discussing between their peers. Challenges anticipated are forming the pairs according to their roll no's and assigning their roles in 1 min time span. To overcome this I gave prior information to the students on the before day to sit according to their roll no's for the next class which became easy for me to form pairs in 1 min.

The success rate of this activity can be defined by the correct solutions provided by the pairs at the end of the activity and It worked very well as I already explained a few problems before the activity students were interested and were confident to solve the problems.

H. Cooperative Learning:

I chose Cooperative learning for the Topic Karnaugh MAP simplification of SOP and POS expression's in the Digital Logic Designing subject. I implemented this activity in the classroom for the Topic because these logical problems are better understood if students work in groups and discuss to simplify the Logical Expressions. When I implemented this activity students were actively taking part and completed simplification in less time, when students work individually on this simplification they will take more time that is why this activity makes them simplify or solve in less time and they were confident to solve more problems.

Before conducting this activity, I explained few simplification problems how to simplify them stepwise
step1: Plot the KMAP and place 1s in those cells corresponding to the 1s in the truth table in the SOP expression and place 0s in other cells.
Step 2: check the KMAP for the adjacent 1s and encircle those 1s which are not adjacent to any other 1s, these are called isolated 1s.
Step 3: check for those 1s which are adjacent to only one other 1 and encircle those to form pair.
Step 4: check for grouping four adjacent 1s and eight adjacent 1s to form quad and octet and make sure that to form minimum no of group without repeating.
Step 5: form the simplified expression by summing product terms of all the groups.
once I felt that students are confident and are able to simplify the problems, I conducted this activity.

I gave 12 questions handout and asked to pick 1 question each group and asked to solve for 5 Minutes after that I asked each group to share their solution to all the groups. In this way all the students are able to solve all the 12 questions in a short span of time.
The time allotted for this activity 5-6 Minutes
Students forming Groups with 5 members each group, there were 12 groups together – 1 Min
Each Group working on each question for simplification– 3 Mins
Each person from each group explaining the simplified solution to all the groups – 2 Mins

Based on the solutions provided by the Group, If I get the correct solution and clear explanation by the group, I can assume that all the students are confident with the Topic and If I get maximum correct solutions from all the groups, I will assume that my activity worked successfully.

4. CONCLUSION:

"In India, most of the engineering educates still use conventional chalk and talk method in class despite there are various methods to engage students. According to the Chinese proverb (Kjersdam and Enemark, 1994), "tell me and I will forget, show me and I will remember, involve me, and I will understand, step back and I will act." Effective Participation was established in students as they were able to corelate the concepts taught theoritically to the experiments and pedagogies being implemented.Bythis, sudents academic performance and classroom research will increase.

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