IMPACT OF MODERN LEARNING THEORIES ON ENGINEERING EDUCATION

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Abstract

Engineering education in India is still based on the age-old model of the teacher regarding the head of the student as an empty pitcher into which he/she pours knowledge, without bothering much about how much of the knowledge impact is absorbed and utilized by the student. However, in the past two decades, significant research has been carried out on how students learn, and new theories of so-called Active Learning have gained acceptance. This paper introduces these active learning theories. It then draws attention of engineering educators to the need of reorienting engineering education in the light of these active learning theories. It shows the teacher may modify his/her present method of teaching so as to enable the students to learn better and to utilize the knowledge gained in a much more effective manner.

1. INTRODUCTION

Engineering education in India is still based on the age-old learning theory wherein the teacher regards the student's head to be a pitcher into which he/she pours knowledge, without bothering about how much of the knowledge imparted has been acquired and utilized by the student. This view is aptly described in the following ancient verse in Sanskrit language.

"Vitarati guru prajne Vidyam yathaiva tatha jade

Na tu khalu tayor jnane vrittim karotyapahanti wa

Bhavati cha punarbhooyan bhedah phalam prati tadyatha

Prabahavati punarbimbodgrahe manir nan mridam chayah"

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(The Guru bestows knowledge on the brilliant and the dull alike. He neither creates nor kills interest in knowledge. Even then there is a great difference in results of learning, in the same way as a jewel sparkles when light is incident on it, while a lump of clay does not).

This traditional view of student learning, known as passive learning theory, is known to have the following consequences :

- Students have a tendency to follow the teacher blindly;
- Tendency to learn by rote rather than understanding what has been traught, leading to so-called surface learning, rather than deep learning.
- Discouragement of critical thinking and originality on the part of the learner.

2. MODERN VIEW OF LEARNING

Recent researches by eminent educational psychologists such as Bennet (1) Hilgard (4), Ormrod (8), Merrill (6) Bowden & Marton (2) have revealed that learning is neither automatic nor is it incidental; learning is very much intentional. Learning is not a passive process but is very much an active process, meaning that the learner is actively involved at each stage of the learning process.

In fact, active learning takes place at five stages, as shown in Fig. 1L1) Sensory structure (SS) (2) Congnitive structure (CS), (3) Emotional Structure (ES), (4) Response Structure (RS), and (5) Feedback Structure (FS).

These stages of active learning are discussed briefly below.:

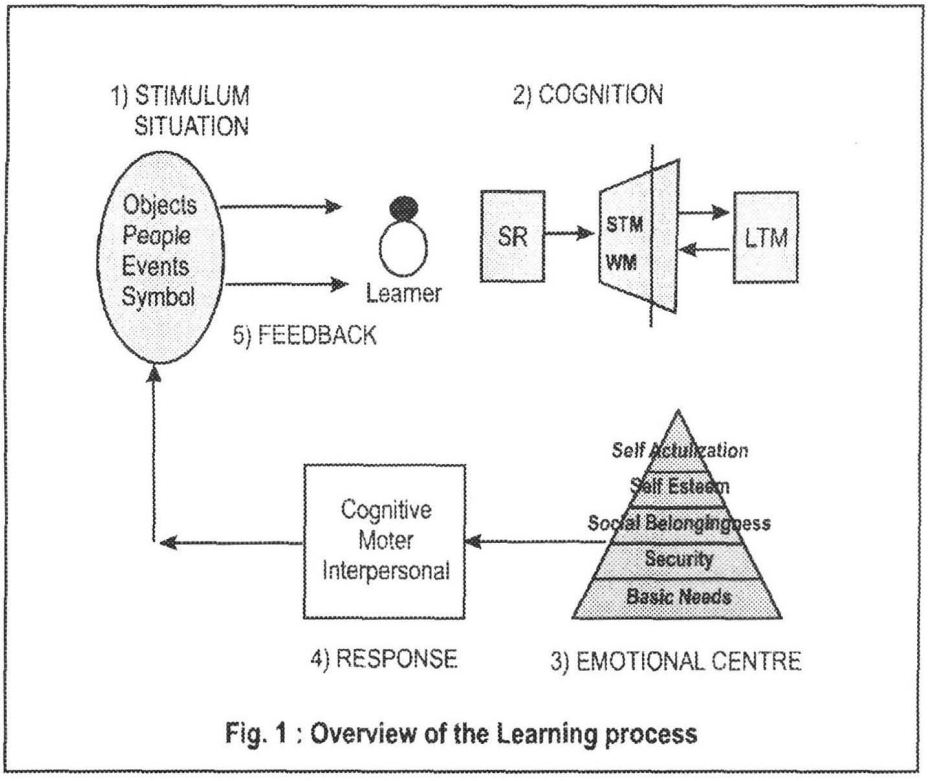

Fig. 1 : Overview of the Learning process

2.1 Sensory Structure (SS) : Knowledge is received by the sense organs, especially by eyes and ears. In engineering institutions it comes in the form of sensing information in lectures, practicals, tutorials, objects, events and activities. In the workplace, knowledge is received in the form of interaction with people, objects, symbols, manuals, &c. Of this, only that information, on which the learner focuses attention, is retained in the sensory register (SR) for further processing

2.2 Congnition Stage : The stimuli in SR are passed on to Working Memory (WM). The new information received is chunked, elaborated, linked with old information and ultimately stored in LTM (Long Term Memory) for future usage.

2.3 Emotional Structure (ES) : associates a positive feeling with learning. By developing an expectancy of success as a result of prior experience, it promotes a sense of self esteem. It enables the learner to sustain interest in learning so that the learner accepts the discomfort, stress, and even pain involved in deep learning.

2.4 Response Structure (RS) : provides *evidence that learning is taking place.* The evidence comes in the form of both overt and covert manifestations. Overt manifestation is cognitive, physical and interpersonal. Cognitive actions include recognition, recall, categorization, explanation, prediction, planning, problem solving. Physical action includes physical skills in handling and manipulation of objects. Interpersonal actions are listening, *communication, presentation, negotiation.* Covert manifestation takes the form of enhanced level of understanding

2.5 Feedback Stage : enables the learner to evaluate his knowledge and understanding vis-à-vis what is desirable, and to take corrective action such as : acquiring additional knowledge, experiencing and experimentation in new ways, reviewing the emotional stance, suitably modifying responses, and getting revised feedback.

2.6 Meta cognition : implies possession of knowledge about how congnition, emotional, response and feedback structures operate, and to make use of this knowledge in order to plan and organize learning.

Meta cognition also means possession of strategic skills to manage cognition by planning and carrying out information search, choice of *appropriate study strategies to suit learning* goals, self evaluation, and contemplation for self-monitoring of comprehension.

3. IMPACT OF MODERN LEARNING THEORIES

Modern active learning theories impact engineering education at three levels :

I Individual Teacher Level

II Engineering Institution Level, and

III University Level

3.1 Impact at Teacher Level : Teacher have traditionally considered themselves as imparters of knowledge. Their goodness as teachers is accordingly adjudged by attributes, such as

i. Ability to plan and structure the lecture material to be taught,

ii. Lively presentation of this material,

iii. Skillful use of high-tech educational aids such as multimedia/overhead projectors,

iv. Generating and sustaining interest of *students in the subject being taught*

v. Cultivation of good relations with students, &c.

However, this traditional attitude needs to be changed in the light of the modern active learning theory, according to which it is not the teacher but the student who is at the heart of the learning process. The teacher's role is not that of an imparter of knowledge, but is that of a facilitator of student learning. This change of role has been succinctly expressed in the following saying:

"He (teacher) is not a sage on the stage but a guide by the side (of the student)".

Time has now come for the teachers to realize this change in their role, to change their mindset accordingly, and to realign their teaching methods accordingly. The steps in this direction are, among others, as follows :

- The first step is for the teacher to study and understand the modern active learning process thoroughly. He/She needs to teach students this active learning process, and to impress on their minds that the initiative in learning is squarely with them.
- The second step is for the teacher to realize that the students' view of seeing a phenomenon is sometimes different from that of the teacher's. In view of this the teacher should desist from imposing his/her way of understanding a phenomenon on the students.
- The teacher should, instead, expose the students to a variety of learning experiences such as lectures, tutorials, practical and project work in the lab where the students learn by doing, problem solving, work experience, computer simulation – especially and synthesis seminars, and group discussion, &c.
- He/she should leave the students to develop their own ways of understanding the phemenoa. It may occasionally so happen that the student's way of seeing and understanding a phenomenon is more powerful than the teacher's.
- The ultimate aim of the teacher ought to be that the student's understanding goes beyond his/her. This feeling is aptly expressed by the following ancient Sanskrit verse

  "Shishyat ichchhet parajayam" (Hope for defeat from the disciple)
- There are two types of learning : surface learning, and deep learning. In surface learning, the stress is on learning by rote; on words, facts and figures; on memorizing the formulae used in solving problems; on passing tests and exams. Comprehension and understanding take the back seat. On the other hand, in deep learning, the stress is on developing understanding and application of the fundamentals to known and new situations.
- The teacher ought to impress upon the students that, although the surface approach may yield short-term gains such as passing tests and exams, it is deep learning that enables them to gain insight into the subject, and would stand by them in the long run.

3.2 Impact at Engineering Institution Level :

Leading engineering institutions have prided themselves as places where the best of teaching is done. They talk about their infrastructure, faculty, library, computer center, extra- and – co curricular activities, etc. However, modern learning theories call for engineering institutions change this mindset. The role of engineering institutions is now to act as learning centres rather than as teaching centres. Towards this end, the engineering institutions have to reorient their role, and take, among others, the following steps:

- Arrange courses on "Modern Learning Theories" for the benefit of teachers, and emphasize on them the need to change their mindset so as to act as facilitator of student learning by adopting steps outlined in Section 3.1 above.
- Widen opportunities of learning on the part of students by way of acquiring the latest lab, computer simulation-design facilities, testing equipment, &c.

- Encourage students to make use of internet facility for getting latest references for their project, seminar and even regular course work.
- Provide hobby centres to give students an opportunity to try out novel ideas in circuits and systems.
- There is no better incentive other than competition to inculcate originality and innovation among students. Accordingly, engineering institutions ought to facilitate students' participation in collegiate, state, national, and even international level student paper and project competitions, held by engineering institutions, professional societies, government agencies, etc.
- Bring about interaction of students with industry leaders by inviting them for lectures, short courses on specialized topics, seminars, prize distribution ceremonies, alumni association functions, etc.
- Arrange for summer training programs in industry in order to acquaint students with current industry practices.
- Form student chapters of professional societies such as Computer Society of India, IEEE, ISA, etc. and make students arrange a variety of chapter activities.
- Depute students to contribute papers and to participate in conferences, seminars, etc. both in India and abroad.
- Arrange value-added programs such as Communication Skills, Personality Development Programs, Ethics and Human Values in Professional Practice, Community Service Camps, Yoga and Stress Relief courses (especially during university exams period), etc.
- Reassure students, with poor academic performance, that a low grade in academics is not the end of their life, and guide them to discover an area in which they have a potential, and can rise to the top.

3.3 Impact at University Level

Traditionally, universities have aimed at three missions : teaching, research, and community service. Bowden and Marton (2) have shown that these missions are but three aspects of only one mission, viz. student learning. Teaching done in the university is meant for encouraging students' learning. In this process of learning, students acquire knowledge, which in new to them, but not for others. This has been termed by Bowden and Marton as learning on individual level. In research, new knowledge is formed which is new in the absolute sense. In this process, humanity learns. Bowden and Marton call this learning on collective level. Community service involves application of knowledge for meeting specific purposes or need of the community. This also involves learning at local level. Similar views have been expressed by Laurillard (5), and in (7).

Thus the primary function of a university is to promote learning at individual, collective and local levels; and it is students' learning that we are concerned with. The most important part of student's learning at the university level is to impart students the ability to take effective action in future situations that are impossible to define in advance today.

Towards this end, the University could impart certain generic skills to the students, which have been defined in (1), as those cross-disciplinary skills that can be transferred from one area of learning to another.

The main generic skills have been identified as skills aimed at : management of self, others, information, and task. These skills are particularly useful in dealing with unknown or unpredictable situations.

4. CONCLUSION

Modern active learning process has been explained in brief at the outset. It has been pointed out that these theories emphasize that it is the student who is responsible for learning. The main impact of these learning theories will be on the teacher who is now to act as a facilitator of student learning rather as imparter of knowledge. Steps for the teacher to reorient himself/herself to this change in role are outlined. The next target will be the engineering institution. How the engineering institution could reorient itself to its new role as learning center is indicated. The university is also required to turn a new leaf and become a learning university. Steps towards this end are given.

All these measures are meant to raise the quality of engineering education in India so as to enable our engineering institutions to hold their own in competition with foreign universities. The outcome is expected to be engineers who will prove equal to their counterparts from any country in the world, and who will enable India to become a world power by 2020 CE.

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