RESTRUCTURING OF TEACHING IN ENGINEERING EDUCATION

★ Narayan Ugar

THE NEED

In view of the spiralling costs of training an engineer, a long term planning for redesign of curriculum is necessary to make the engineering education cost effective, within the reach of the aspiring learner, without sacrificing its quality. The scope of restructuring has been confined to the area of instructional techniques in this paper.

THE CYCLE OF curriculum design resembles a program in QUALITY IMPROVEMENT by J.M.Juran as shown in Fig.1

BUILDING BLOCKS FOR LEARNING

The following concepts from learning theory (Bloom and Pegeot) could be valuable in analysing teaching problems or in the choice of intructional model.

ACTIVE LEARNING

Learning takes place when the learner is actively involved with the instructional material. In addition to hearing and seeing the instructional material, (s)he

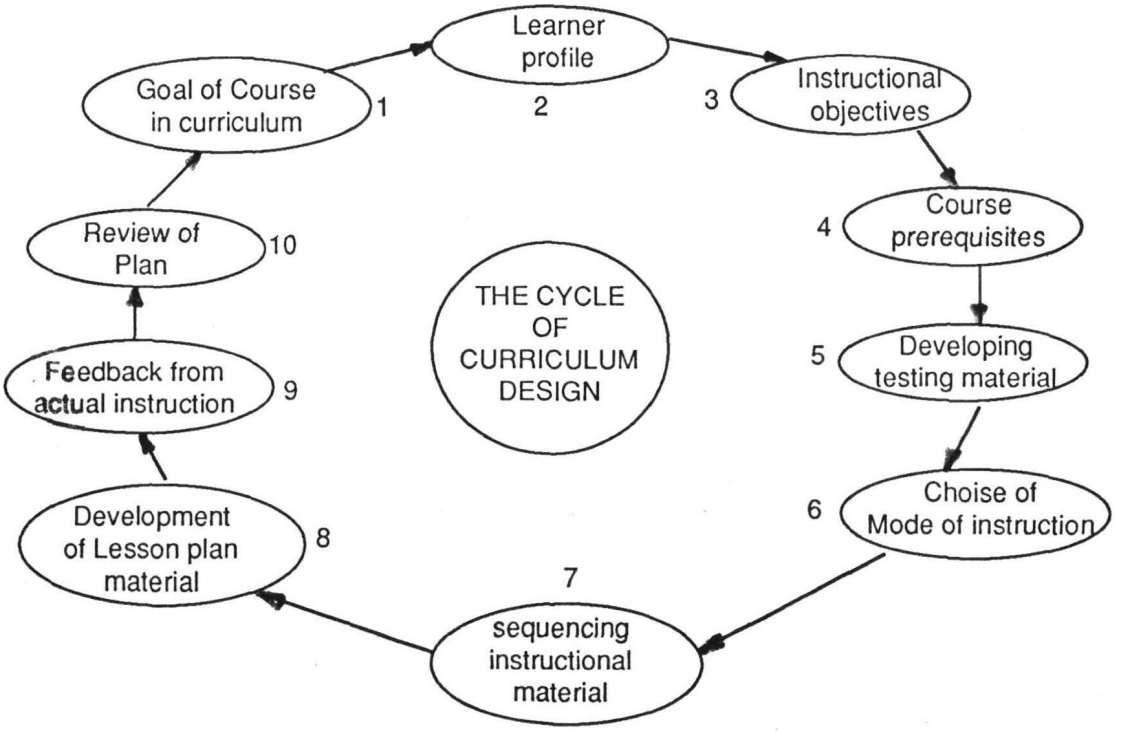

FIG - 1

★ Systems Consultant "Savitri", Nirmal Baag, Pune 411 009

should be able to think about the topic, do homework on it and should be able to communicate with others on that subject.

FEEDBACK TO LEARNER

Feedback lets the learner know what (s)he is supposed to learn and whether (s)he has learned it. The faster the feedback, the more motivation to learn and less efforts in unlearning the misconeptions.

POSITIVE REINFORCEMENT

Positive reinforcement like a word of appreciation on learner's achievement increases motivation and learner's involvement in active learning.

DISTRIBUTED versus BATCH LEARNING

Studying on regular schedule results in increased and more effective learning as compared to a heavy dose of Batch learning with lengthy spans of time.

LEARNING IN SMALL STEPS

Learning the subject matter in small logical chunks helps the learner to grasp the concepts in gradual steps. When accompanied by frequent feedback, it prevents accumulation of imperfect understanding and helps in the comperhension of complex concepts.

AWARENESS OF COURSE OBJECTIVES

Learning becomes more effective when learners are informed about the coverage of the subject matter in the course. This helps the learners to allocate appropriate time for different subjects in the course. This, in turn, helps in reducing the anxiety in the minds of the learners, thereby instilling a feeling of self-confidence and security in them.

LEARNING at SELF PACE

Every individual has his own pace of learning. When instruction is aimed at an average pace, learners whose learning pace dose not match with the pace at which instruction is imparted, loose interest in learning.

A self-paced instruction strategy generally leads to superior results in learning for disciplined learners.

EDUCATIONAL TECHNOLOGY

Some promient instructional technology methods include the following :-

MODULARISATION

Modularisation is concerned with breaking down the subject matter of a course into mutually exclusive self-contained modules that have their objectives, instructions, suggested tutorials as well as suggestions for additional reading.

LEARNING FOR MASTERY

These courses are modular in nature, have detailed objectives, distributed learning, regular tesing and instant feedback. The learner has to master mostly what the GURU considers to be important. The criterion for passing is set generally at a high level, hence the learner works hard to master the contents of the course. With frequent evaluation of performance, both long-term and short-term retention in learning for mastery are superior to the other instructional techniques.

COMPUTER MANAGED INSTRUCTION

A digital computer can act as a TEACHING MACHINE in the sense that it can present instructions, tutor the learner, evaluate progress and provide the feedback, It can help in managing instruction by random selection of tests from a database of tests based on the evalution of the learner performance by the computer itself. The computer can maintain course records by documenting the score in class and home tests as well as in periodic examinations.

In case of on-line testing of proficiency, sophisticated expert systems can be developed. In addition to maintaining scores

for all learners, the system can be designed to provide learners with references for further study of problems, they could not solve satisfactoriy. The system provides for retrieval of their incorrect responses to assist them in analysing the bottlenecks.
The system performs analysis on test items to assess their difficulty level and also charts the distribution of scores for different learner groups.

PROCTOR

This is again a personalised system of instruction. The role of proctors is basically to grade the performance in the presence of the learner and provide the learner with immediate feedback. The use of proctors permits repeated testing, some form of tutoring, immediate scoring and a marked enhancement of the personal-social aspect of the educational process.

INSTRUCTIONAL TELEVISON

Like the computer, television is used in a variety of ways in eduction. It can be used to present an entire course to a second, distant or a dispersed audience, as with the Open University.

Closed Circuit TV with strategically placed monitors is used to provide learners to view expriments and demonstations which are either too dangerous for direct exposure , or which would otherwise require many repetitions to small groups of the learners. With the avaiability of TV tapes, the learner can study the course material at his pace and convenience.

SURVEY OF SOME TEACHING METHODS

G.F. Paskusz of Houston University and James Stice of Texas University, in their paper in the proceeding of the IEEE, 1978, have deveoped two matrices. The interaction between the teaching methods and their building blocks and the other, the UTILITY MATRIX representing the effect of choice of methods on learning.

The teaching methods considered for their impact on the building blocks are :
a. Formal lecturing
b. Lecture-discussion
c. Discussion group
d. Lab teaching
e. Self-paced instuction
f. Bloom's taxonomy
g. Programmed instruction
h. Computer-assisted instruction
j. Open university
k. Audio-tutoring

The cross-table indicates the

TEACHING METHODS andtheir BUILDING BLOCKS

BUILDIG BLOCKS	Active Learning	Feedbk	+ve reinf	Distr learng	Small steps	Obj learng	Pacing
(a) formal lecture	W	W	WI				I
(b) Lect-disc	W+	W+	W+	W			I
(c) Disc-group	P	P	P	P-		W	I
(d) Lab-teaching	P	P-	W+	W+	W	P-	I
(e) Self-paced	P	P	P	P	P	P	S
(f) Bloom's method	P-	P	W+		P	P	I
(g) Prog-instr	P	P	P	P	P		S
(h) CAI	P	P	P	P	P		S
(j) Open Univ.		W	W	W			I
(k) Audio-tutor	P	P	P		P	P	S

LEGEND : P - Prominent component W - Weak component
S - Self-paced I - Intructor-paced

contribution of Discussion groups, Lab-instruction, Self-paced learning, Bloom's taxonomy, Programmed instruction, Computer-aided instruction and Audio-Video tutorials to be significant candidates for consideration in redesigning of the curriculum. The Utillity Factors considered are :

a. Learner Acceptance
b. Short Term Retention
c. Long Term Retention

d. Development of ability to learn
e. Required Faculty effort :
- * Development
- * Slower Learner Use
- * Need For Special Audio Visual Facilities

f. cost

1. Depends on learner motivation, self-aided instruction have a very high impact on the costs.

OPEN UNIVERSITY mode

The open university concept is an alternative to the rigidities of campus life. The purpose of open university is to make college

THE UTILITY MATRIX

Utility Factor	ST Reten	LT Reten	Lrnr Accpt	Lrng ability	Faclty Efort		AV Faciity	Cost
					Dev	SS		
Formal Lecture	M	M	M	L	M	L to M	L	L to M
Lect-disc	M	M	M+	L+	M+	M+	L	L to M
Disc group	M+	M+	M+	M	M to H	M to H	L	L to M
Lab-teaching				1	H+	H	H	H
Self-paced	H	H	H	H	H	M	M	2
Bloom's method	H	H	M+	M	M	M		L to M
Prog-instr	H	M+	3	L-	H	L	L	L toM
Audio-tute	H	M+	H	L	H+	M	M+	H
CAI	H	M+	H	L	H+	L	H	H+
Open uni	M	M	H	H	H+	M	H+	H+

LEGEND :
H - High M - Medium L - Low

confidence, and whether the learner per forms singly or in groups.

2. Depend on whether proctors are paid.
3. Usually Low for superior learners and High for slower students

The utility matrix indicates that Lab-instruction, Audio-Video tutoring system and Computer-

education avaiable to those who either do not afford it or those who can not attend college as regular students because of distance from the campus, work schedules and other responsibilities. The open university thus offers courses designed for independent study away from the campus.

In presenting these courses, teaching is primarily done by the use of television, radio and newspaper articles, augmented by self-study texts and group discussion meetings. Generally, learners are not required to come to the campus except for examination. Help from the instructor or the tutor is available on the campus.

The open university concept is not viable for engineering education for following reasons :

a. Learner activity varies as in the traditional lecture.
b. Feedback is weak and delayed because of the lack of immediate personal interac tion between learner and the counsellor. The same holds for positive reinf orcement.
c. Because examinations are even more infrequent than in the traditional lecture, distributed learning is apt to give way to periodic cramming.
d. Step size is not mandated by the method but is controlled by the individual course design.
e. Since the presentation are scheduled, the method is instructor paced.

CONCLUSION

The analysis of the two matrices indicates that the instructional methods involving :

a. Lab-instruction
b. Audio-video tutoring system and
c. Computer-aided instruction

have a very singnificant effect on the costs and these instructional methods form prominant components of the building blocks for engineering education.

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