SUMMER SCHOOL

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METHODOLOGY OF TEACHING AND TRAINING

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LECTURE NOTES

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Sri Jayachamarajendra College of Engineering
Mysore - 570 006

and

Regional College of Education
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P R E F A C E

The engineering profession has made great progress on the road towards efficient utilization of natural resources. If all engineering teachers could measure up to the ideal since teachers being an essential in the educational process, with knowledge of effective methods of teaching and of the Psychology of learning, the profession could advance still further, and in addition could greatly improve its use of human resources. The professional development of engineering teachers is to be furthered since, the charge some times is, that engineers are not interested in methods of teaching and some feel that the entire emphasis of the training of an engineering teacher should be on subject matter rather than on methods of teaching. Hence the process of orienting the engineering teacher to his teaching work is highly important. An engineering teacher must show growth not only as an engineer, but also of at least equal importance in ability as a teacher.

One of the fundamental problems in increasing the prestige and improving the status of teaching is to make the profession acutely aware of the tremendous area in teaching, methods and techniques, psychology and sociology of learning and teaching, which remains unexplored, to make it aware of the great opportunity for research and creative thinking within the classroom itself. As such while recognising the greater need for orienting the engineering teachers to new methods and techniques in teaching a two-fold crisis is rapidly approaching in engineering education. On the one hand even as the need matures for many more engineering teachers to handle the wave of students because of many new colleges coming up, we find ourselves in a grim but losing competition with industry for the services of our engineering graduates and even of our present staff members of the colleges.

On the other hand, the need is growing for a new type of engineer of sufficient breadth, depth and versality to develop the technologies necessary to utilize the new discoveries that modern science is showering upon us. This calls for a uniquely qualified type of engineering teacher. Hence there is a need for adequate training of teachers for this dawning new era in engineering education. Such a preparation should make them alert to new ideas and techniques and a propensity for stimulating their students to apply them imaginatively; make them creative in the practice of their profession, creative in their approach to teaching who can stimulate creativity in their students.

With this end in view the Regional College of Education, Mysore, and Sri Jayachamarajendra College of Engineering, developed a programme on engineering teaching to familiarise the engineering teachers with the methods and principles of teaching and learning.

The training or orientation programme includes areas on principles of pedagogy, objectives of engineering education, curriculum planning, advanced educational psychology, models of teaching, students' motivation, evaluation of students' progress, personal relation, micro-teaching in skill development, stress and strain on college campus, improving labboratory and workshop practices, new concepts in methodology of teaching and training, philosophy and sociology of engineering education, instructional technology and communication skills and the like. The programme also covered perspectives and philosophy, knowledge of the learner and learning process, management of learning and learning

resources, communication techniques and strategies, tools and techniques of evaluation, human relationships and classroom management.

The four week long programme employed various techniques and strategies, lecture-cum-discussion, panel discussions, seminars, film shows, work sessions and field trips.

The Summer School on Methodology of Teaching and Training for teachers of Engineering College with such impressive programme has become possible with the generous support and assistance of the Indian Society for Technical Education which is acknowledged with grateful thanks.

The Summer School programme and the materials contained herein is sure to open up new frontiers and concepts for every one interested in this vital task of improving engineering education and stimulate and inspire the novice as well as experienced engineering teachers who wish to mature and improve teaching.

DR. K.P. NAYAK
PROF. M.H. DHANANJAYA

Co-ordinators

WHAT IS ENGINEERING AND SCIENCE - - PHILOSOPHY

Dr. K.P. Nayak

Every satellite that goes into orbit, we often hear, is a scientific success; while every one that does not is an Engineering failure. Statement of this sort can exist because people seem not to know or to understand the difference between science and Engineering.

What then, is engineering and what then is science?

Even though it is sometimes difficult to draw the distinction in actual practice science and engineering are clearly not the same thing. Science aims at the discovery, verification, and organisation of facts and information. Its goal is an understanding of the world we live in and of ourselves as part of that world. It seeks truth and knowledge. The scientists puts nature under his miscroscope to discover how it behaves and why it behaves that way. Having done this, he seeks to order the facts he discovers into general, or universal laws through induction and hypothesis - laws that can stand as an accurate, qualtitative description of the organisation and operation of nature.

Science is the explanation of the material universe for the purpose of seeking orderly explanation of objects and events.

We get science 'from the old French word meaning ' to know' 'Engineering' derives from the old French word meaning 'to produce'. To an engineer knowledge is not an end in itself but is simply the raw material from which he fashions structures, machines, and processes. He directs his attention primarily not to the discovery of facts and information but to their application and utilization. His task is to take the knowledge acquired through the study of an existing system - that is, nature,- and use it to design a new system to serve a human purpose. The fulfilment of the basic needs of food, shelter and clothing are basic to the engineering, with emphasis on performance.

If science is basically analytical, engineering is basically creative. If the characteristic, method of the scientists is induction that of the engineer is deduct on. If understanding is the basic goal of the scientists, then utilization is the basic goal of the engineer .

Study and investigation take the scientist in the direction of discovery; practice and application and utilization of knowledge carry the engineer towards creation.

Even though a clear-cut distinction can be made, science and engineering do not exist in separate vacum mutually exclusive of each other. The fact that engineering depends upon science for the raw material from which it creates its designs is clearly understood. Science depends upon engineering for the tools with which to carry out its investigations. The scientific study of atomic behaviour in producing the light and heat of the stars resulted in information that made it possible for engineers to design reactors. These reactors, in turn, permitted the scientists to refine their knowledge, producing information that enabled the engineers to harness nuclear energy in generating electricity, in preserving foods, and the like. The design of huge electronic computers, an engineering achievement, has opened up vast new fields of inquiry for the scientists. Scientific investigations into solid-state physics are opening up completely new areas of application for engineers.

In recent years there has been much confusion between the terms 'Scientist' and 'engineer' If a distinction can be made we can say that the function of the scientist is primarily one of analysis. He seeks to know if a certain state of conditions exist, what would follow, what are the natural consequences. The primary problem of the engineer is one of synthesis; he wishes to find hat conditions must be assembled in order to make a desired result follow. This means that the engineer must interate from the world of knowledge all the methods of attack which may be brought to bear on the problem,; Synthesis is necessarily an art. All this indicate that one of the fundamental problems in engineering education is how to develop the ability to transfer ideas learned from the solution of one set of problems to an attack on a totally new set of problems.

We must recognize that knowledge, in and of itself, is sterile and useless unless it is put to use. It becomes important only after it has been put to use in the affairs of man. This is the job for which engineers are specially trained. This is the work to which they are omitted. No one else can to it as well as they.

The distinction between scientists and engineers draws attention to the essential moral obligations. Although scientists share with other human beings certain moral obligations, the gathering of facts and information is not in itself, an activity that involves morality. Facts and information are morally neutral. They could be used to advance evil purposes and virtuous ones.

WHAT IS ENGINEERING

Engineering is what an engineer does.

The label "Engineer" and the attendant job functions and responsibilities differ from place to place and from time to time.

Engineering is professional practice and is not just an academic study of technical principles and techniques.

There is a wide spectrum of functions performed by an Engineer like research, development, design, construction, operation, production, maintenance, testing, teaching. Engineering is not network of formulae, data and rules bound to something. The engineering activities are based on the principles of sciences and combined appropriately with experience and judgement and thus engineering practice demands an extensive base of science and reasonable quantum of experience, reasoning and judgement.

The activities of engineering are not the usual routine or repetitious ones; but they imply innovation, synthesis and creativity.

Science has as its goal - an understanding of nature and its phenomenon and how they operate i.e., the role of a scientist is that of a seeker of knowledge through study and enquiry and investigation and generally adopting the methods that are inductive in character and imply hypothesising. The basic function would be that of analysis and the end is the knowledge and understanding of how nature operates and is organised. The entire attention is directed to the discovery of laws or principles and theories that can explain the observations of the natural phenomena and helping one to predict their occurance. In other words, science seeks to know when a certain state of conditions exist, what would follow and what are the natural consequences.

Contrasted with this, the goal of engineering is the creation of devices and facilities to satisfy in a better way a known human need. The role of an engineer is thus innovative and creative in character, adopting the approach of application of the verified scientific laws and based on the experience of the earlier practices. Thus, the knowledge of science found out, organised and classified systematically is the raw-material

for an engineer to fashion out things required by human society. Thus, his attention is mainly directed to the creative utilisation of knowledge through synthesis. Thus, engineering practice attemots to find out what conditions must be assembled in order to obtain the desired result.

Thus, engineering is committed to the translation of theory into reality. Such an activity by its very nature implies "ethics"; hence, the knowledge has to be applied with judgement in accordance with the values prevalent in a given society at a given time. Thus, the focus is not merely on what could be done but more importantly on what should be done.

Earlier, their was quite a lot of time-gap between the discovery of a scientific law or principle and their application in Engineering. Now-a-days, this time-lag is very short. Thus, engineers of today are expected to be equipped with training and talent to effect a rapid transition from a scientific discovery to engineering creation.

An engineer engaged in research will direct most of his attention to the discovery of new facts and principles about systems and to identify those that lend themselves to further development. Thus, new ideas are conceived. Engineering development focuses its effort on the evaluation of alternative solutions that can be thought of and these new ideas of engineering research are brought to a safe stage of feasibility and thus concerns itself with working out chance-possibilities to design improvement. Engineering design as the name implies performs the actual design of new systems and the facilities giving the specifications. Thus, the function involves the application of new and verified principles to a concrete use on the basis of the ideas of research and development. Design is considered to be the heart of engineering and characterises it.

As a part of the design activity, engineering adopts the technique of optimisation and the trade-off amongst the conflicting parameters that may be involved in a solution to solve the problem on hand.

A technician is normally expected to perform routine tasks relying on established techniques which are generally accepted by group. Any change in an established technique

can only be suggested by an engineer. An engineer because of his training and ability will be able to transfer himself adequately and shift appropriately to any new situations not covered by the usual prescriptions and the prevailing established techniques. As a professional, engineer creates his own operational rule based on theory and principles and also discovers and uses refined techniques. But, an engineer is not just a repository of information and techniques and engineering is not knowledge and techniques recorded and systematically organised. Of late, engineering functions take the form of cooperative team work and project work.

Engineering activities comprise of study of technical literature, analysis at desk, investigation in laboratory, visual thinking and communication, report writing, project work, design, optimisation, and decision making. Engineering is thus "the pursuit of the possible, always the necessary and seldom the perfect".

The typical functions, performance, requirements, work responsibilities, creative ability,, intelligent judgement, concern for the human good, sensitivity to finding the needs in a given environment and such other personal characteristics of an engineer have been listed above, in a way identifying the task and the elements of tasks which differentiate the profession of engineering from that of a scientist on one side and the technician on the other.

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TECHNICAL EDUCATION IN THE EMERGING INDIA

Three decades of the post independent era of India has seen impressive strides made in all walks of life. If the food production has more than doubled, industrial production has increased more than 4 times and power generation has gone up many-fold. Naturally a sound base has been prepared for Science and Technology. In fact the Science and Technological growth of the country is reflected by the developments mentioned above. But there is no escape from noting the fact that in spite of these magnificient developments, more than half the population of the country is below the poverty line even after 30 years of independence.

India is a land of wide differences and contrasts. Bullock carts and Jet planes ply simultaneously in this country. There are a large number of illiterates and semi skilled persons simultaneously living and working with Scientists with knowledge comperable to the best in the world. The very fact that we have been able to earn a place in the map of space technology as the 6th nation in the world, by orbitting a satelite is a testimony to the ability of technologists in the field of developed science. It is also a tribute to the ability of the scientists of this country to have mastered the most complicated intricate and sophiscated space technology.

India is now ranked third in the world to have the largest number of trained technical personnel and ranks among the first ten major industrialised countries in the world. A looked at the number of technical personnel available shows a 7 to 8 times increase in their availability compared to what it was 25 years ago.

The very contrasts cited above indicate a need for great thought to be devoted by technical educationists as to how best we can improve and impart technical knowledge which is going to be of immediate use to the country.

Technical Education has assumed an important role in the development of the country and as such technical education has increased many-folds in the past two decades. I might say that the technical education in our country has exploded instead of being expanded in the past 25 years. Several Five year plans, planning commission, man-power estimates and other organisations

hav e and evergy to predict the needs of the cou ide the planning of technical education in our country. ... how or other, there seems to be some communication gap between the two, i.e. man power commission and other organisations connected with it and the planners of technical education. A clear example of the significance of the statement is the glut of engineers that took place in 68-70 and the possible repercussions that we in Karnataka will face in 1984-85. The intelligentsia of the country have been discussing the pros and cons of the expansion of the technical education, the type of education that is required for the future and the associated problems. The Institution of Engineers (India) had arranged a big seminar in this connection wherein several ideas and suggestions have been noted.

Some of the salient points that need our concerted effort to analyse are:

1. An analysis of the existing type of technical education, its merits and demerits.

2. Whether the present mode of education is suitable in future, if so how lon , if not when the change is required. Once the change is contemplated what will be the type of change.

To appreciate and understand the above statement we have to note that the world is changing rapidly. There is a wide gap between the developed country and the developing coutry. The progress in technology of developed countries is so great that unless we in developing countries make some special effort to by-pass the conventional methods of study, it will never be possible for us to catch up with the development taking place in the advanced world. This almost leads us to wonder whether there will be a situation resulting in collapse of conventional method of education imparting basic concepts before the student becomes eligible for higher knowledge.

The other important feature, that bothers many of us is the diminishing reserve of natural resources in the world particularly in the light of advanced technological development. Commercial sources of energy of limited stock are being exhausted at a very rapid rate resulting in a big question as to what would happen to the future generations in the next century. This would naturally remind every educationist that it is time that our

education must also incorporate the education as to how best we can optimise the use of existing natural resources such that we can stretch their availability to a very long period, simultaneously go in quest of new resources. Thus technical education of the future is almost made up of a wide spectrum of speculation on optimal use of the existing resources and needs for development of new resources for future.

The Technical Education in our country is broadly classified into three sections -(1) Education of the highest standard to the highest level awarded by prestigeous institutes of technology and similar education imparted by the Regional Engineering Colleges and Engineering colleges of long standing, (2) Technical Education at the Diploma level by the Polytechnics and (3) skilled workmen training at I.T.I. level. The demand for all types of technicians from I.T.I. to Ph.D's is increasing, but of late the demand is in specific fields rather than general. Thus the primary need for the future technological training would be to identify the possible fields where different levels of knowledge of technology are required and fashion our education to suit these specific needs. A few enthusiastic prophets have enunciated degree ofadvanced studies in new emerging branches like Energy Engineering, Environment Engineering, Space Engineering, Rural Engineering and Human Engineering. But there is no dispute about the fact that whatever technology you would like to impart or acquire should be made available to the "majority" - that is the rural sector. Therefore the term appropriate technology or more specifically rural technology demand greater importants in the future planning. Just like a bare-foot doctor, a bear-foot engineer is the need of the day. In fact appropriate technology, a term coined by the people interested in the field which has raised several questions of controversies is worthy of discussion. There is a school of thought which believes that whatever technology we have now is the appropriate technology. But several others contend that the technology developed, which will enable us to use the available materials at different locations to be more useful to the artisons in the villages so that their products are more sophisticated. Long lasting, less laborious is defined as appropriate technology.

One other important feature that most of us have been talking about is the inter action between the Engineering Institutions and the industries on the involvement of the institution in the engineering developments taking place in a region. It is

truely a sad stats of affairs that the institutions, development authorities and the industries are sealed in insulated compartments without any repport between them., thereby nullifying possible outcome of evolution of an appropriate technology and its development.

There has been a feeling of dissatisfaction or semi dissatisfaction in the type of education imparted by the technical Institutions in the country. The main objection come from the industires who absorb the graduates and the contention is that the education imparted in the institutions is not of immediate use, but in fact this particular comolint has been existing eversince the Universities have been imparting technical education. Most of the people who have contributed to the tremendous develooment to the country have gone through the portals of these institutions only, undergoing this type of standardised education. Naturally this leads to the fundamental belief that the duty of the university is to technically equip an individual so that he will be able to have a GRASP OF THE BASICS of all subjects connected with technology. It has not been the effort of any technical institution to impart particularised training to graduates for them to end up as a special machinist or designer. All the while it is the effort of Colleges to produce "General Engineers" with enough knowledge and ability to adoot themselves to suit the requirements of a particular individual or factory where they join. By and large an Engineer who is found to be not at all adequately suited to a particular industry at the beginning becomes a big contributor to the production and development within 6 months of training. Thus we can say that there is no basic lacuna in the methodology adopted by the institutions in imparting technical education.

A statistical analysis of the employment potential of the graduates coming out of the technical Institutions presents a very peculiar picture. Nearly 80% of the graduates are absorbed as maintenance engineers, where as 10 to 15% go as sales engineers while 10 to 5% will be production engineers, designers or enter Research and Development establishments. Thus we note that a majority of the product is absorbed in maintenance which according to us is a routine matter. Many maintenance engineers have felt that all the knowledge they acquire through strenous study and training is of no significant use to them in their a vocation and for a sales engineer the degree is only a passport to enter into a profession. In the light of this, every educationist must give a tremendous amount of thought as to what our curricullum for engineers should be.

But engineering is fundamentally committed to the translation of scientific facts and information to create machines, structures, materials, processes, and the like that can be used by men. This is, by its very nature, an activity that does involve morality. This fact has been accepted and recognised by leading engineerrs. One of the definition of engineering itself states that 'engineering is the profession in which knowledge is applied with judgement for the progressive well-being of mankind'. This means that engineering is more than 'Know how' and more than 'craftsmanship with less emphasis on creative aspects: The pharses 'with judgement' and progressive well-being of mankind' involves more than know how'. They involve social decisions. They involve leadership in what should be done as well as in what could be done. They involve civilization and for the sort of lives we live in it.

This distinction has definite implications for the training of Engineers. Therefore the engineering student must be given the opportunity to practice and to learn design, to create something new, rather than to explore why how something works that laready exists. A person does not become an engineer by studying the procedures of science. He learns if he is going to learn through the successful completion of a design problem.

To plan any program of education properly, however, it is necessary to have an idea of and to take into account the various types of work performed by the gradutes of that program. One must also establish a definition of engineering. One such definition is as follows:

"Engineering encompasses the application of the various principles of the science, combined with experience, to the study, design and development of engineering systems composed of circuits, energy converters, sturctures and processes in various combinations. It is concerned with the analysis, synthesis and prediction of the behaviour of these systems under specified conditions, in terms of function, personnel, cost, materials, time and safety. It is concerned further with the welfare of mankind, individuality and collectively, and directs its efforts in pursuing the above activities towards an improvement of man's welfare, conveniences and standard of life".

Graduates of a programme designed to conform to this definition will do widely varied types of work. It has been postulated that they may, however, be divided roughly into five general groups.:

a) The Engineer - scientist:

Those engineers are creative and devote their major attention to the discovery of new facts about engineering systems and to the recognition of those scientific facts which will lend themselves to engineering development.

b) The creative design engineer:

These are the individuals who actually design new engineering systems and put newly discovered principles to use.

c) The functional engineer:

These are the engineers who employ orthodox methods and established principles in the design of conventional details of manufacturing plants and public utilities, and they build, operate and maintain those plants and the related equipment.

d) The engineer technician:

These engineers devote their attention to the more routine tasks and as testing, inspection and analysis.

e) Engineering graduates in on - engineering work:

A large number of engineers in each of the above categories find themselves, administrative executive or ownership posts in industry, government and utilities.

In designing a program and implementing that program engineering faculties immediately find themselves in a dilema. It is generally felt by educators and representatives of industries employing the majority of engineers that curricula can be devised which incorporate the philosophies above and which will come reasonably close to satisfying the needs of all concerned.

There are lessons to be learned here, also by the faculties of our Engineering Colleges. To guide their students, teachers of Engineering should know the distinctions between science and Engineering and the above five general groups and maintain their proficiency as engineers. This means that they must continue to practice engineering - that is they must continue to be involved in the design and creation of new machines, new systems, and the like. Teachers of engineering to be most effective in their teaching, should also be practicing engineers, in a position to see and experience at first hand the solution of difficult design problems by competent practicing

If the knowledge we discover is to mean anything to us, is to be of any value to us, we must continue to honour and to teach its use through creative engineering design.

Experience in some Universities like the State University of Iowa which instituted an approach to the improvement of Engineering education provided programmes to familiarize the faculty with the methods and principles of teaching and learning and this has produced results in bringing excellence in Engineering education.

Based on this approach and philosophy and with this concept of engineering - what it means, engineers could make a definite effort to improve engineering education.

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PANEL DISCUSSION PROBLEMS OF ENGINEERING TEACHERS

REPORT REGARDING

Principal M.H.Dhananjaya, as the moderator of the panel, started the discussi n on the subject. He broadly classified problems of Engineering Teachers, and led the discussion. He was of the opinion that the major problems faced by an Engineering Teacher could be classifeed as Academic, Social and Administrative.

Prof. Rame Gowda, stressed the need of a good library with lots of journals so as to enable the teacher to update his knowledge. He suggested that the Sabatical leave should also be made available to the teachers. This, he said, would improve the financial as well as the academic conditions of the staff.

He differenciated between a teacher and a lecturer, and was of the opinion that only teachers need the knowledge of psychology and lecturer should guide the students by opening new avenues.

Prof.M.S. Jayadev, disaussed on the cadre rules. He suggested the implimentation of the time bound promotions and condemdex the existing system. He was of the opinion that injustise is being done to part-time teachers because they are paid a consolidated pay, which is less than the basic pay of a permenent lecturer. This, he felt, makes the fresh Engineers to go for other jobs. He stressed the need for the evaluation of teachers for promotions.

Prof. M.S.Jayadev, said that because of the lack of a fixed and rigid schedule regarding the starting and closing of the semester, the teachers lose their vacation. He felt this should be rectified.

Dr.Shanth Kumar, felt the need of specialists. But he said the funds are not usually available for research. He ~~xixd~~ said the teachers should be given the opertunities for research and requested the teachers to use the available facilities for this purpose.

Finally Prof.Dhananjaya, summerised the points raised

OBJECTIVES OF ENGINEERING EDUCATION IN INDIA

Dr. K.P. NAYAK

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There has been much talk in recent years of how to improve Engineering education, but less discussion is devoted to defining clearly what is meant by good engineering education. To educate Engineers effectively, teachers must have a clear concept of their goal, objectives and the concept of engineering.

A good engineering education can be defined as one which provides the student with sound technical knowledge. It enables the student to have an appreciation for the application of the fundamental laws, concepts, and techniques to the solution of engineering situations. With this appreciation and embroyonic ability he may go into various types of industry in various capacities equipped to meet the problems which will face him realistically and not be submerged by them if they cannot be solved by textbook formulas.

Such a student will be capable of interpreting the physical significance of a problem, will be able to reason through the various amifications of the situation facting him and will be able to evolve a reasonable solution based on his composite /knowledge / interpretive ability, and reasoning skill. In his engineering practice conventionality must begin to yield ground to creativity.

The distinction between conventionality and creativity in engineering practice has been eloquently discussed by C.D.Fulton who writes: (*)

"Conventional engineering is a network of formula, data, rules, and static science bound into a firm disciplince. It demands rationality, order, repetition, patience, caution, thoroughness and scholarship. This kind of engineering is a machine-like process and machines are beginning to be employed to do some of it. It is indeed a considerable part of engineering and we have done a good job of teaching it. Creative engineering on the other hand, operates on emotions, imagination, chance, boldness, rebellion, abadon, flight of fancy and every other quality which distinguishes the live human being from the inanimate machine".

The time is at hand when we mucht emploit those qualities of our students that distinguish them from machines. This calls for a fresh approach to the teaching of engineering.

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(*) Fulton, C.D. 'On teaching Creative Engineering' Journal June 55

There has been much talk in recent years of how to improve Engineering education, but less discussion is devoted to defining clearly what is meant by a good engineering education. To educate engineers effectively, teachers of engineering must have a clear concept of their goal, objectives and expected changes in student behaviour,- development in their knowledge skill, attitudes and habits.

A good programme can provide the student with sound technical knowledge and develops in him the following abilities:

a) To express his needs in an inteligent, understandable way,

b) To search the literature for the information he needs and to evaluate it with respect to his problem.

c) To look for and detect the similarities between his problems and those of other fields.

d) To investigate and solve for himself those problems which are:

i) Sufficiently simple not to warrant a search of the literature

ii) unlike problems that have been discussed in the published literature.

The curriculum of the engineering college must be presented in such a way that it should develop real analytical ability in the students, anf from this, encourage creative thinking on the part of the student. True creativity is a characteristic which relatively few graduates will acquire.

On the basis of the above and the philosophy and definition of engineering it is possible to list the objectives of Engineering education in India in brief as follows ;

1) The student should be encouraged to appreciate the value life long learning.

2) He must know the fundamental laws, concepts, techniques to the solution of engineering situations.

3) He must be capable of interpreting the physical significance of a problem, reason through the various remifications of the situation facing him, to evolve a reasonable solution based on his composite knowledge, interpretative ability, and reasoning skill.

4) He must be able to habitually orient his thoughts towards a proper attack utilizing all the background information he has acquired.

5. He must be above to develop a real analytical ability and creative thinking.

6. He must be above to develop his skills in the proper methods of communication of ideas through the use of his language, ability to portray his ideas in drawings and sketches and facility in the use of mathematics.

7. He must be able to develop an understanding of the important natural laws and concepts. The natural laws in physics, Chemistry, etc should receive greater emphasis.

Laboratory experience should be a part of the program for it serves the following purposes:

1. Exercises which confirm theoretical concepts and the laws discussed in formal classrooms give the student a feeling a confidence, a conviction that the statements presented are truths.

2. The laboratory experiences enable the student to see how well his ideal system predicts the operation of an actual system. This is a climatic experience which brings the classroom work into clearer focus.

3. The student gets many opportunities to develop ability facility in the use of measuring instruments of all types.

4. The laboratory affords them a chance to make the observation under expert guidance of actual Engineering devices in operation.

5. The laboratory serves as a means by which the student develops skills in both analysis and synthesis.

6. Oral and written reports enable the student to gain additional facility in the use of the language of engineering.

7. The student must develop skill in the use of modern computing equipment.

8. The student should have a knowledge of regulation and control. All modern engineering systems involve some kind of control or regulating instruments. This objective immediately points out the need for experiences in systems analysis and synthesis.

(*) 9.

10. The student must become familiar with the mode of analysis used by engineers, and is given exercies in the four general methods of attacking a problem, namely, experimental, analytical, use of

(*) 9. The student should be acquinted with modern industrial processes.

models and analogs and finally in what might be termed the art. By art is meant the application of judgement based upon experience.

11. The student must be encouraged to be on the lookout for ways and means of correlating and integrating fundamental knowledge. He must be taught to think clearly and logically and to learn how to apply his knowledge to new situations.

12. In order that the graduate engineer can enjoy the status of a respected citizen in his community and become a worthy member of his profession he must develop an appreciation of other values too, such as those termed human, moral, social, artistic, economic and professional. Such a set of values are to be developed.

If the objectives listed above can be attained, the engineering educator will have succeeded in his task of producing trained men for the engineering activities of the future. It must be remembered that a curriculum is merely a vehicle for accomplishing these objectives and that it is fundamentally the instructor/ teacher who must see that the proper interpretation is placed and that use is made of the subject matter of the various courses to achieve these objectives of engineering education. It involves appreciation techniques, and abilities on the part of the instructor/teacher which require intensive preparation and leadership. These cannot be achieved without effort, but with responsibility for the professional lives of many students and indirectly the safety and living standards of all, education must make that effort and must strive to achieve the goals and objectives with desired results.

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ISTE SUMMER SCHOOL ON METHODOLOGY OF TRAINING AND TRAINING

TAXONOMY OF EDUCATIONAL OBJECTIVES - I

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In our concern for specification of objectives, we seem to have underplayed one of the most important functions of objectives. We know where the goal posts are. But there may be many paths leading towards them. Which of them shall we choose? Another question that is not unrelated to this may also be asked. What if the goals are not worth striving for? Or what if they are too difficult to reach? In other words, while it is one thing to be able to write objectives clearly, it is quite another to be able to judge which of them are relevant and appropriate for a particular course of instruction. Aiming too low loads to dissatisfaction while aiming too high may result in frustration.

We have, therefore, to examine whether there are qualitative differences among the objectives. This amounts to examining whether there are qualitative differences among behaviours, since objectives have been stated in terms of changes in behaviours of students. Even commonsense tellsus that there are such differences. The ability to prove a theorem learnt in a class on geometry is quite different from the ability to solve a rider based on the theorem. The former depends almost entirely on the information acquired in the class while the latter demands an excursion into an area beyond such information. Skill of remembering is emphasized in the former while more complex intellectual abilities are required to achieve the latter objective. We have, unconsciously, classified objectives into simple and complex. Perhaps the key to the problem of an appropriate choice of objectives lies here.

One of the most detailed and most popular classification schemes available to us is the one developed by a group of researchers working under the direction of Prof. Benjamin Bloom.

The scheme groups educational objectives under three broad domains - the cognitive, the affective and the psychomotor domains. The Cognitive domain, which is our main concern in this session, includes those objectives, which deal with the acquisition and manipulation of factual information. The affective domain includes objectives which describe changes in interest, attitudes and values and the development of appreciations and adjustment. The psychomotor domain concerns itself with the development of physiological skills. Each domain in turn is divided into a number of levels.

It should be noted that what is classified in this scheme is not instructional methods used by teachers or the particular subject matter they teach. It is a classification of the intended outcomes of teaching, expressed as intended behaviours of students. The intended behaviours related to mental acts or thinking are the focus of the classification under the cognitive domain. This area therefore, includes behaviours such as remembering; reasoning; problem solving; concept formation and to some extent creative thinking. The objectives are arranged from the simplest behaviour to the most complex. In this sense the scheme is not just a classification like the Dewey decimal system of classification of books. Since the rule - simple to complex- is used in ordering phenomena, a rule, that can be validated by demonstrating its consistency with theoretical views, the classification scheme merits the title 'taxonomy'.

The organization in the cognitive domain considers the objectives among six major classes:

1.00 Knowledge

2.00 Comprehension

3.00 Application

4.00 Analysis

5.00 Synthesis

6.00 Evaluation

The numbers are suggestive of a hierarchical order. For definition of and the further subdivisions in each class reference may be made to the condensed version of the taxonomy.

For the present discussion the objectives under the cognitive domain can be divided into two parts. One is the simple behaviour of remembering knowledge and the other, the more complex behaviour of the abilities to use knowledge in various situations.

1. Knowledge: Probably the most common objective in our educational system is the acquisition of knowledge. By knowledge, we mean that the student can give evidence by recalling or recogni zing, some idea or phenomenon with which he has had experience in the educational process. It is defined as little more than the remembering of the idea or phenomenon in a form very close to that in which it was originally encountered.

One compelling reason for the teaching of knowledge is that it is regarded as basic to all the other ends and purposes of education. Problem solving and thinking cannot be carried out in a vacuum, but must be based on knowledge. Even the manipulative and motor skills assume some knowledge about the materials, methods or tools that are used. This can be said of objectives under the affective domain also. Interest and increase of information are related. Attitudes and appreciations are to some extent based on knowledge. There are many other reasons for teaching knowledge. These extend from as simple a reason as the simplicity with which knowledge teaching and testing can be done, to the status accorded to knowledge in our culture. An educated person is expected to be a very knowledgeable person.

While there could be ample justification for inclusion of knowledge objectives, a number of curricular decisions about them needs to be made. Questions like 'how much knowledge' 'how precise' 'what best organization of knowledge' etc. should be asked before

framing these objectives. For instance, one has to strike a balance between all the information available in a particular subject and that which is most basic to the subject.

2. Intellectual abilities: Although acquisition of information is an important outcome, it would be unfortunate if this becomes the sole aim of education. It would be necessary to aim at abilities to use such information in new situations and problems. In such a situation the student ought to be able to select an appropriate technique for attacking it and to bring to bear the required information, both facts and principles. This requires an analysis of the new situation; a background of knowledge that can be utilized and some facility in discussing appropriate relations between past experience and the new situation.

The justification to include such abilities as the outcomes of education becomes apparent from a consideration of the rapidly changing needs of the society. The nature of the problems to be faced and solved in the future cannot be predicted in all their details. We have therefore, the task of preparing individuals for situations that cannot be foreseen and all that can be done by education is to develop generalized ways of attacking problems. Research in educational psychology suggests that such generalized abilities have a better transfer value to new situations than the special abilities that are suited to one particular culture. Psychology again usggests that outcomes of education that can be generalized and applied with success in a number of different situations are more permanent than those encountered only a few times during an educational programme.

This brief account of the taxonomy merely supports the contention that a scheme can be worked out to discover qualitative differences among objectives. By frequent reference to the

condensed version which gives the definitions and brief descriptions of each subclass of objectives under the cognitive domain, one can classify the objectives one writes for a particular course of instruction. This would enable one to see whether there has been too much emphasis on one class of objectives. Any such unbalanced distribution can then be remedied.

The derivation of a teaching strategy from the objectives thus selected is not within the scope of this discussion. It is however obvious that teaching a particular item of content at the knowledge level and comprehension or application level call for different strategies for teaching. The teacher has to first decide at what level the content should be taught; which means he has to make a decision about the objectives. He can then design learning experiences so that these will be achieved.

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THE NATURE OF GOOD TEACHING

Dr.K.P.Nayak

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The importance of teaching at the College level involves many things. Some of these are concerned with what goes on in the classroom and some with the motivation of students and some with techniques adopted by the teacher. It is evident that knowledge of subject matter alone does not provide complete qualification for teaching at the College level.

There are many components to the job of good teaching and some of them are :

1. The starting of a career in college teaching;
2. How to win and hold the good-will of students;
3. How to operate classroom routine;
4. How to keep student interest at a high level;
5. How to make your teaching practical, functional or worthwhile;
6. How to plan and organise college courses;
7. How to prepare functional syllabuses and textbooks for college courses;
8. How to manage related library and textbook materials;
9. How to direct the exchange of ideas;
10. How to persuade, convince or influence college students;
11. How to speak effectively in the college classroom;
12. How to illustrate or demonstrate your ideas;
13. How to direct student practice or performance;
14. How to promote originality, research and invention, creativity;
15. How to improve the learning techniquesof college students;
16. How to fit instruction to varied abilities and needs;
17. How to maintain proper levels of work and mastery;
18. How to teach many students at one time and manage large classes;
19. How to check up students accomplishments;
20. How to help young people to plan and manage their lives;

There is a need for comprehensive research and study to formulate criteria of good teaching, systematic procedures for appraising it, and the most effective steps for its improvement. In any discussion of improving college teaching it seems necessary that there be some statement as to what constitutes good teaching; what is the nature of good teaching. Effective learning is the result that the good teacher is after. The change in performance that a good teacher is concerned with is the production of increased competence in the field being studied. This involves (a) Producing an understanding of the fundamentals (b) developing the ability to use the fundamentals in new situations. These become prime objectives in the educational process.

A single sentence answer to good teaching in engineering is : Good teaching is the development of the student's ability to do things for themselves. Engineering at professional level consists in essence in creating and doing things on one's own responsibility, and development of this capacity is the essence in creating and doing things on one's own responsibility, and developing this capacity is the fundamental aim of engineering education. The extent to which this is accomplished is the measure of success of our teaching. Engineering lends itself to the development of ability to do things for oneself. Our whole scheme of education is conducive to that objective. The combination of recitation, laboratory, and design classes, all dealing directly with things to be done and ways of doing them is an ideal arrangement for learning both the how and the why of things. Therefore it lends itself to good teaching.

The best and worst teachers of engineering :

Widely accepted and readily available criteria of teacher qualities related to good teaching are listed above. The judgments of those who underwent the teaching of specific individual teachers will throw some light on the dimensions of the characteristics of teachers of engineering.

A sample of more than 2500 engineers was picked at random from the membership of the five leading engineering organisations. Those engineers were asked to rate each their best and worst teacher of engineering on the Purdue Rating Scale for instructors, a graphic scale which rates the instructor on ten traits on a graphic scale of 0 to 100.

The ten traits, the mean rating of the best teachers, the mean rating of the worst teachers, and the different between the means is given below:

Traits rated	'Best' means	'Worst' means	Differences
Interest in subject	88.6	55.8	32.8
Sympathetic attitude towards students	83.4	43.8	39.6
Fairness in grading	87.6	59.6	28.0
Liberal & progressive attitude	82.4	40.2	42.2
Presentation of subject matter	88.8	30.4	58.4
Sense of preparation & honour	79.8	33.1	46.7
Self-reliance & confidence	86.8	50.7	35.1
Personal peculiarities	77.5	42.6	34.9
Personal appearance	81.7	64.2	17.5
Stimulating intellectual curiosity	87.1	27.7	59.4

It is evident that there is little resemblance between these two groups of teachers.

On one trait personal appearance does the group of worst teachers even approach the best teacher group and this difference is far better than the one percent level of confidence. It should be noted that the differences between the best and worst teacher means on traits 5 and 10 - presentation of subject matter and stimulating intellectual curiosity - are greater than one-half the total possible range.

Since the mean best teacher of each organisation possesses very nearly the same amount of the quality being rated on each trait, and this amount, while varying from trait to trait, maintains very nearly the same relative rank in the ten traits in each organisation, and since the same statement holds true for the mean-worst teacher, it thus seems likely that there is a hierarchy of trait values for all teachers of engineering. Consequently, a tentative hypothesis is advanced that the comparative rank of each of the ten traits would be virtually identical for any unselected group of teachers for a single university or from a number of universities.

The best teacher in engineering, then, is a teacher who is distinguished from his less able colleagues in that he has a much greater interest in the subject taught, that he is very able in the presentation of the subject matter, and that he can, to an unusual degree stimulate the intellectual curiosity of his student. The worst teacher of engineering has also interest in the subject matter but lacks ability to stimulate the intellectual curiosity of his students and does not present the subject matter of the course in a satisfactory fashion. The size of the mean of the best and the worst teacher can provide a sort of a floor and a ceiling by which

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In a survey to learn the characteristics of successful and unsuccessful instructors the composite of traits which in the opinion of the students marks a successful instructor in engineering is the following:

1. A thorough knowledge of and interest in his subject;
2. Experience in te ching. V riety in meth ds and in the presentation of material;
3. Ability to arouse enthusiasm with sincerity;
4. An understanding of and an interest in students as people sense of humour and a fairness to all students;
5. Effectiveness of expression, pleasant personality and a wholesome outlook in life;
6. Friendliness and a sensitivity of and a respect for students and their ideas and thoughts;
7. An ability to explain, ability and willingness to answer question;
8. Ability to convey ideas clearly and concisely and an ability to explain and present the material so that the students can easilty follow;
9. Correlation of subject matter with present day events and living;
10. Personal characteristics such as courtesy, neatness, tact, dignity and diligence;

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A two fold crisis is rapidly approaching in engineering education. On the one hand, even as the need matures for many more engineering teachers to handle the wave of students that is about to engulf us, we find ourselves in a grim but losing competition with industry for the services of our products and even our present staff members.

On the other hand, the need is growing for a new type of engineer of sufficient breadth, depth, and versatility to develop the technologies necessary to utilize the new discoveries that modern science is showring upon us. This calls for a uniquely qualified type of engineering teacher. How to meet both of these needs simultaneously is a problem.

The necessary characteristics of this new type of engineering teacher include a solid grounding in the fundamental concepts and practices of engineering and also an alertness to new ideas and techniques and a profensity for stimulating their students to apply them imaginatively. The teachers must be creative who can stimulate creativity in their students and therefore should be familiar with the techniques of teaching proficient in educational technology. If his graduate course in engineering does not contain this component attempts should be made through some other programmes like summer schools to study graduate teaching methods and techniques in such important areas of College teaching as evaluation of achievement, personal counseling, and classroom technique. They should provide some grounding in educational psychology. They should have a perspective of the whole educative process as well as a knowledge of most basic techniques needed by a teacher.

Equally useful might be the philosophy and psychology of education, the art of counseling, techniques of communicating ideas and the science of evaluating student achievement. Psychologist and engineers can work together in the future in this important area of education.

The College of engineering of the State University of Iowa attempted to provide on the job training for the improvement of teaching of engineering. The initial work here consisted of defining the objectives of engineering education and of finding the means by which these objectives could be achieved. The course provided combine the techniques and philosophy of engineering instruction and courses in pedagogy in which he learns the content and fundamentals of teaching.

The course aimed especially at young teaching personnel consisting of assistants, instructors, and assistant professors, but faculty members of higher rank are invited to attend in the trial period. The course content included the following:

1. Introduction : The need for teacher training; problems faced by the instructor; history of education; great names in teaching and their philosophies; use of teaching aids.
2. Educational Psychology: Psychological factors in students; mental abilities; aptitude and aptitude testing; the effect of social and economic background on college study.
3. Reading and retention : Problems involved in reading ability methods of improving reading; retention of material read .
4. Adult Education :
5. Examinations : Internal Assessment - examination and evaluation of student performance - criteria;
6. Aims of teaching - Criteria of good teaching ; etc.
7.

7. Administration and Management :

The results of this programme has been encouraging. Although the programme at Iowa was voluntary, attendance at the meetings indicated interest. Senior faculty members, were rather more interested than were the young instructors. The suggested books at this course have been acquired by most and these are : Effective teaching by F.C.Morris and Instruction manual of Georgia Institute of Technology.

The IOWA programme brought faculty members closer to one another through the concern with common problems and the realization of the fact that there is no one or easy road to good teaching. This proved that engineering teacher must be an excellent engineer and must be an excellent teacher. These are the requirements with which we have been concerned and for which these courses are designed.

We hope the participants will get themselves enriched and get benefitted by this programme. They will find themselves as excellent creative engineers and excellent creative teachers of engineering.

ISTE SUMMER SCHOOL ON METHODOLOGY OF TEACHING
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Educational Objectives

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As in any other human enterprise, education is expected to be directed towards certain goals. The goals set for education are determined by the needs of the society and by the aspirations of the human mind. Decisions about these are generally made by policy makers at the highest level. Since goal formulations are based on very broad principles, goal statements are usually in very broad terms. Some examples of such statements are:

Engineering education should

(i) enable the student to develop such natural talents as he may have and provide him the knowledge, skills, understanding and appreciation that will encourage him to pursue a personally rewarding career of work,

(ii) enable the graduate engineer to conscientiously, wisely and competently supply valuable engineering services to the society,

(iii) train the student to be flexible in his approach so that he will confidently face and solve new technological problems that may crop up in the twenty-first century.

These are lofty ideals for a professional course. The qualities emphasised in these statements are what a future employer in industry would be demanding in his executives. But are we, as teachers, consciously guiding the students towards these goals? During the day-to-day instructional activities, are these goals in the focus? We can at best give vague answers to these questions. A little analysis will tell us why. The statements are too general for us to be able to say whether these goals are being achieved or not. It is not surprising therefore, that teachers and to some extent even curriculum makers tend to leave the achievement of these goals entirely to chance. They seem to believe that if they concentrate their efforts on covering their subject matter, the student would inevitably develop along the lines prescribed by the goals. Whether such a development has taken place or not is to be determined much later by the society for which our educational system is supposed to prepare the youngsters. Since this state of affairs is obviously not satisfactory, we, the educators must examine whether evaluation of student development and its relation to the aims prescribed, can be built into the process of education itself.

The first requirement for this is to seek a clarification of the goals. The broad statements have to be recast in terms that can be readily related to what happens in a classroom or in a course of instruction. This 'translation' of the goals leads to the 'objectives' of education. One can, for instance

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state that the objectives of engineering education are to enable the students to acquire:

(1) Knowledge of pertinent scientific facts and principles, including the mathematical language in which they are expressed.

(2) Proficiency in recognizing and using appropriate concepts and models in the analysis of engineering problems.

(3) Willingness to approach problems creatively, to seek solutions beyond those attainable by established methods,

(4) Awareness of the realities of practical engineering problems with particular emphasis on:

(a) Social and legal consequences

(b) Need for evaluation of approximations

(c) Need for compromise between conflicting requirements and so on.

This effort is only the first step towards clarification. The statements still suffer from being rather general and words like 'Knowledge', 'Proficiency', 'Willingness' and 'Awareness' which are the key words in the statements are ill-defined. They can be interpreted in different ways by different people. The statements would therefore bear a further analysis.

The approach that is gaining ground in educational circles is to look at the problem from the point of view of the effect of a particular instructional effort on the behaviour of the student. 'What is it that he is able to do at the end of instruction, which he was not able to, before?' The student being able to <u>solve</u> a problem in Applied Mechanics, to <u>perform</u> an assigned job on a machine, and such other abilities are consequences of instruction. The student was not 'born' with these abilities. If the intent of instruction was to give these abilities, the success of instruction can readily be measured on the basis of whether the student was able to 'solve the problem' and 'perform the job' or not. Thus the statements of general objectives can be sharpened by introducing terms such as 'define' 'draw' 'differentiate' etc. which refer to some observable student behaviour(action).

Before writing such precise instructional objectives the teacher will have to consider a number of factors, among which are the needs and desires of the students, the expectations of the institution and community and the limitations imposed both by state requirements and the nature of the subject itself. A good way to begin is to analyse the content of the course with respect to the particular skills that can be developed through it and the key ideas contained in it. This lengthy list of objectives can then be transformed into precise instructional objectives along the following lines.

The first step is to specify an observable terminal behaviour for each objective. This gives a description in terms of activities that a person can actually see and measure, exactly what a student will be expected to do at the end of instruction. Terms such as 'state', 'list', 'calculate'

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'sketch' 'define' etc are more effective in describing expected behaviours than are terms like 'know' 'learn' 'understand' and 'appreciate'. Consider the following examples:

(1) The student will understand 'Ohm's law'

(2) The student will calculate the resistance of a conductor.

The word 'understand' in the first objective is subject to interpretation. Precisely what should the student be able to do to demonstrate that he has understood? Is it enough if he states Ohm's law? Should he write the mathematical relationship implied in the law? Should he use it to calculate one of the quantities when the other two are given? The second statement pinpoints the expected behavior - 'to calculate' and hence is able to convey the intent of instruction more clearly.

Some terms such as 'identify', 'differentiate' and 'solve' are less ambiguous than terms like 'know' and 'learn' and yet they describe purely mental activities - activities that go on in the student's head - and are therefore not directly observable. A means by which the activity can become observable needs to be specified in such cases. 'Identify in writing', 'differentiate by recording on a check list' or 'record on paper the step-by-step procedure' and such phrases indicate to the students what specific activity will be accepted as an overt demonstration of the competence and hence reduce anxiety on the part of the students.

Having decided on the observable terminal behaviour, the second step in writing precise objectives is to prescribe the condition under which the behaviour is demonstrated. These may be in the form of time limits, use of special aids and equipment or source from which the information required to solve a problem may be obtained and so on. Consider the following examples:

The student will be able to:

(1) State what the shape of a permissible matrix multiplication would be.

(2) State what the shape of a permissible matrix multiplication would be without carrying out the multiplication.

The condition under which the behaviour should manifest is prescribed in the second statement. Similarly the statement

"given a meter with several scales and a range switch, the learner is able to identify the scale corresponding to each setting of the range switch"

conveys the instructional intent more clearly than the statement

"to be able to read electrical meters".

The conditions under which the terminal behaviour should occur are usually prescribed in the form of words like

given a problem of the following class...
given a list of...
given a matrix of inter-correlations...
given a standard set of tools...
without the aid of slide rule...
without the aid of tools.... etc.,

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The requirement to be satisfied is that the target behaviour would be recognized by another competent person, and other possible behaviours would not be mistaken for the observed behaviour.

We have till now emphasized and described what the student should be able to do at the end of instruction and under what conditions. The final step in the clarification of instructional intent is, with respect to how well should the student be able to demonstrate his newly acquired competence. It will be necessary to prescribe a minimum acceptable standard of performance as evidence of the success of the instructional programme.

Probably the most obvious way of specifying this is setting a time limit or a limit for the length of the answer

> "To be able to complete a drawing" and "To be able to complete a drawing within one hour"

obviously refer to different requirements. But, very often, one may regard this time limit as a condition rather than a standard of performance. The drawing may be presented at the end of the hour, thus satisfying the objectives stated above, but it may be a poor performance. It will therefore be necessary to sharpen the statement of the objective by adding the necessary phrases referring to the quality of the work to be completed within one hour.

Some examples of ways in which performance standards are specified are the following:

The student will:

(1) Given four sets of symptoms, state the source of the troubles in an instrument in at least three of the cases.

(2) Given.....solve the problem to the nearest whole number.

(3) Use the chemical balance well enough to weigh materials accurately to the nearest milligram.

(4) Explain in writing the proper use of the wood lathe including: (a) the procedure for mounting the material; (b) the proximity of the rest block to the material; (c) the speed of the chuck; (d) the proper use of tool bit; and (e) safety precautions.

(5) Given an otherwise properly functioning TV receiver of any of the following models ....., adjust the ion trap to achieve a uniform raster within a period of five minutes.

While the statements (1) to (3) prescribe quantitative terms for the minimum acceptable standard of performance, (at least three of the cases, to the nearest whole number), the other two prescribe a qualitative standard(minimum elements in an explanation, quality of illumination on a TV screen).

We have, in this session, discussed one important aspect of planning an instructional procedure. It may be surprising

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to realize that the first step in planning is to define the intended results of instruction. The most important point to be considered is what students should be able to do after instruction. Making this decision is the most complex and difficult step in planning for instruction. But once armed with objectives that communicate unequivocally what is expected of the students, one would be ready to tackle the other problems of instructional design, like selecting the appropriate learning experiences and designing a suitable evaluation procedure.

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A P P E N D I X

Condensed version of the
Taxonomy of Educational Objectives

Cognitive Domain

K N O W L E D G E

1.00 KNOWLEDGE:

Knowledge, as defined here, involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting. For measurement purposes, the recall situation involves little more than bringing to mind the appropriate material. Although some altration of the material is required, this is a relatively minor part of the task. The knowledge objectives emphasize most the psychological processes of remembering. The process of relating is also involved in that a knowledge test situation requires the organization and reorganization of a problem such that it will furnish the appropriate signals and cues for the information and knowledge the individual possesses. To use an analogy, if one thinks of the mind as a file, the problem in a knowledge test situation is that of finding in the problem or task the appropriate signals, cues, and clues which will most effectively bring out whatever knowledge is filed or stored.

1.10 KNOWLEDGE OF SPECIFICS

The recall of specific and isolable bits of information. The emphasis on symbols with concrete refrents. This material, which is at a very low level of abstraction, may be thought of as the elements from which more complex and abstract forms of knowledge are built.

1.11 KNOWLEDGE OF TERMINOLOGY:

Knowledge of the referents for specific symbols (verbal and non-verbal). This may include knowledge of the most generally accepted symbol referent, knowledge of the variety of symbols which may be used for a single referent, or knowledge of the referent most appropriate to a given use of symbol.

*To define technical terms by giving their attributes, properties, or relations.

*Familiarity with a large number of words in their common range of meanings.

1.12 KNOWLEDGE OF SPECIFIC FACTS :

Knowledge of dates, events, persons, places, etc. This may include very precise and specific information such as the specific date or exact magnitude of a phenomenon, It may also include approximate or relative information such as an approximate time period or the general order of magnitude of a phenomenon.

*The recall of major facts about particular cultures.

*The possession of a minimum knowledge about the organisims studied in the laboratory.

1.20 KNOWLEDGE OF WAYS AND MEANS OF DEALING WITH SPECIFICS

Knowledge of the ways of organizing, studying, judging, and criticizing. This includes the methods of inquiry, the chronological sequences, and the standards of judgment within a field as well as the patterns of organization through which the areas of the fields themselves are determined and internally organized. This knowledge is at an intermediate level of abstraction between specific knowledge on the one hadd and knowledge of universals on the other. It does not so much demand the activity of the student in using the materials of it does a more passive awareness of their nature.

1.21. KNOWLEDGE OF CONVENTIONS:

Knowledge of characteristic ways of treating and presenting ideas and phenomena. For purposes of communication and consistency, workers in a field employ usages, styles, practices, and forms which best suit their purposes and or which appear to suit best the phenomena with which they deal. It should be recognized that although these forms and conventions are likely to be set up on arbitrary, accidential, or authoritative bases, they are retained because of the general agreement or concurrence of individuals concerned with the subject, phenomena, or problem.

*Familiarity with the forms and conventions of the major types of works, e.g., verse, plays, scientific papers, etc.,

*To make pupils conscious of correct form and usage in speech and writing.

1.22. KNOWLEDGE OF TRENDS AND SEQUENCES

Knowledge of the processes, directions, and movements of phenomena with respect to time.

* Understanding of the continuity and development of American culture as exemplified in American life.

* Knowledge of the basic trends underlying the development of public assistance programs.

1.23. KNOWLEDGE OF CLASSIFICATIONS AND CATEGORIES

Knowledge of the classes, sets, divisions, and arrangements which are regarded as fundamental for a given subject field, purpose, argument, or problem.

*To recognize the area encompassed by various kinds ofproblems or materials

*Becoming familiar with a range of types of literature.

1.24. KNOWLEDGE OF CRITERIA

Knowledge of the criteria by which facts, principles, opinions and conduct are tested or judged.

*Familiarity with criteria for judgement appropriate to the type of work and the purpose for which it is read.

*Knowledge of criteria for the evaluation of recreational activities.

1.25 KNOWLEDGE OF METHODOLOGY :

Knowledge of the methods of inquiry, techniques, and procedures employed in a particular subject field as well as those employed to investigating particular problems and phenomena. The emphasis here is on the individual's knowledge of the method rather than his ability to use-the method.

*Knowledge of scientific methods for evaluating health concepts.

*The student shall know the methods of attack relevent to the kinds of problems of concern to the social sciences.

1.30 KNOWLEDGE OF THE UNIVERSALS AND ABSTRACTIONS IN A FIELD :

Knowledge of the major schemes and patterns by which phenomena and ideas are organized. These are the large structures, theories, and generalizations which dominate a subject field or which are quite generally used in studying phenomena or solving problems. These are at the highest levels of abstraction and complexity.

1.31. KNOWLEDGE OF PRINCIPLES AND GENERALIZATIONS:

Knowledge of particular abstractions which summarize observations of phenomena. These are the abstractions which are of value in explaining, describing, predicting, or in determining the most appropriate and relevant action or direction to be taken.

*Knowledge of the important principles by which our experience with biological phenomena is summarized.

*The recall of major generalizations about particular cultures.

1.32 KNOWLEDGE OF THEORIES AND STRUCTURES:

Knowledge of the body of principles and generalizations together with their interrelations which present a clear, rounded, and systematic view of a complex phenomenon, problem, or field. These are the most abstract formulations, and they can be used to show the interrelation and organization of a great range of specifics.

*The recall of major theories about particular cultures.

*Knowledge of a relatively complete formulation of the theory of evolution.

INTELLECTUAL ABILITIES AND SKILLS

Abilities and skills refer to organized modes of operation and generalized techniques for dealing with materials and problems. The materials and problems may be of such a nature that little or no specialized and technical information is required. Such information as is required can be assumed to be part of the individual's general fund of knowledge. Other problems may require specialized and technical information at a rather high level such that specific knowledge and skill in dealing with objectives emphasize the mental processes of organizing and reorganizing material to achieve a particular purpose. The materials may be given or remembered.

2.00 COMPREHENSION:

This represents the lowest level of understanding. It refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications.

2.10 TRANSLATION:

Comprehension as evidenced by the care and accuracy with which the communication is paraphrased or rendered from one language or form of communication to another. Translation is judged on the basis of faithfulness and accuracy, that is, on the extent to which the material in the original communication is preserved although the form of the communication has been altered.

*The ability to understand non-literal statements (metaphor, symbolism, irony, exaggeration).

*Skill in translating mathematical verbal material into symbolic statements and vice versa.

2.20 INTERPRETATION:

The explanation or summarization of a communication. Whereas translation involves an objective part-for-part rendering of a communication, interpretation involves a reordering, rearrangement, or a new view of the material.

*The ability to grasp the thought of the work as a whole at any desired level of generality.

*The ability to interpret various types of social data.

2.30 EXTRAPOLATION:

The extension of trends or tendencies beyond the given data to determine implications, consequences, corollaries, effects, etc., which are in accordance with the conditions described in the original communication.

*The ability to deal with the conclusions of a work in terms of the immediate inference made from the explicit statements.

*Skill in predicting continuation of trends.

3.00 APPLICATION:

The use of abstractions in particular and concrete situations. The abstractions may be in the form of general ideas, rules of procedure, or generalized methods. The abstractions may also be technical principles, ideas, and theories which must be remembered and applied.

*Application to the phenomena discussed in one paper of the scientific terms of concepts used in other papers.

*The ability to predict the probable effect of a change in a factor on a biological situation previously at equilibrium.

4.00 ANALYSIS:

The breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between the ideas expressed are made explicit. Such analyses are intended to clarify that communication, to indicate how the communication is organized, and the w in which it manages to convey its effects, as well as its basis and arrangements.

4.10 ANALYSIS OF ELEMENTS:

Identification of the elements included in a communication.

*The ability to recognise unstated assumptions.

*Skill in distinguishing facts from hypotheses.

4.20 ANALYSES OF RELATIONSHIPS:

The connections and interactions between elements and parts of a communication.

*Ability to check the consistency of hypotheses with given information and assumptions.

*Skill in comprehending the interrelationships among the ideas in a passage.

4.30 ANALYSIS OF ORGANIZATIONAL PRINCIPLES:

The organization, systematic arrangement, and structure whi hold the communication together. This includes the "explicit"

as well as "implicit" structure. It includes the bases, necessary arrangement, and the mechanics which make the communication a unit.

*The ability to recognize form and pattern in literary or artistic works as a means of understanding their meaning.

*Ability to recognize the general techniques used in persuasive materials, such as advertising proraganda etc.,

5.00 SYNTHESIS:

The putting together of elements and parts so as to form a whole. This involves the process of working with pieces, parts, elements, etc., and arranging and combining them in such a way as to constitute a pattern or structure not clearly there before.

5.10 PRODUCTION OF A UNIQUE COMMUNICATION:

The development of a communication in which the writer or speaker attempts to convey ideas, feelings, and/or experiences to others.

*Skill in writing, using an excellent organization of ideas and statements.

*Ability to tell a personal experience effectively.

5.20 PRODUCTION OF A PLAN, OR PROPOSED SET OF OPERATIONS:

The development of a plan of work or the proposal of a plan of operations. The plan should satisfy requirements of the task which may be given to the student or which he may develop for himself.

*Ability to proposed ways of testing hypotheses.

*Ability to plan a unit of instruction for a particular teaching situation.

Contd.....

5.30 DERIVATION OF A SET OF ABSTRACT RELATIONS:

The development of a set of abstract relations either to classify or explain particular data or phenomens, or the deduction of propositions and relations from a set of basic propositions or symbolic representations.

*Ability to formulate appropriate hypotheses based upon an analysis of factors involved, and to modify such hypotheses in the light of new factors and considerations.

6.00 EVALUATION

Judgements about the value of material and methods for given purposes. Quantitative and qualitative judgements about the extent to which material and methods satisfy criteria. Use of a standard of appraisal. The criteria may be those determined by the student or those which are given to him.

6.10 JUDGEMENTS IN TERMS OF INTERNAL EVIDENCE

Evaluation of the accuracy of a communication from such evidence as logical accuracy, consistency, and other internal criteria.

*Judging by internal standards, the ability to asses general probability of accuracy in reporting facts from the care given to exactness of statement, documentation, proof etc.

*The ability to indicate logical fallacies in arguments.

6.20 JUDGEMENTS IN TERMS OF EXTERNAL CRITERIA

Evaluation of material with reference to selected or remembered criteria.

*The comparison of major theories, generalizations, and facts about particular cultures.

*Judging by external standards, the ability to compare a work with the highest known standards in its field-especially with other works of recognized excellence.

THE MANAGEMENT OF LEARNING AND LEARNING RESOURSES

Dr.K.P.NAYAK

Technology of education and training:

Education and training now represent the largest single national expenditure and many economists and politicians now believe that it is doubtful if society can any longer afford the high costs and low productivity associated with instruction. Teaching and training is a highly skilled professional activity and a great deal of what teachers and lecturers do both within and outside the classroom, involves making decisions of one kind or another. The emphasis on the management of learning is now to give teachers and lecturers useful and valid criteria against which they can choose alternative courses of action in the light of the assu-mptions they make about the nature of teaching, the objectives to be realised, the resources available, and the character of the students involved.

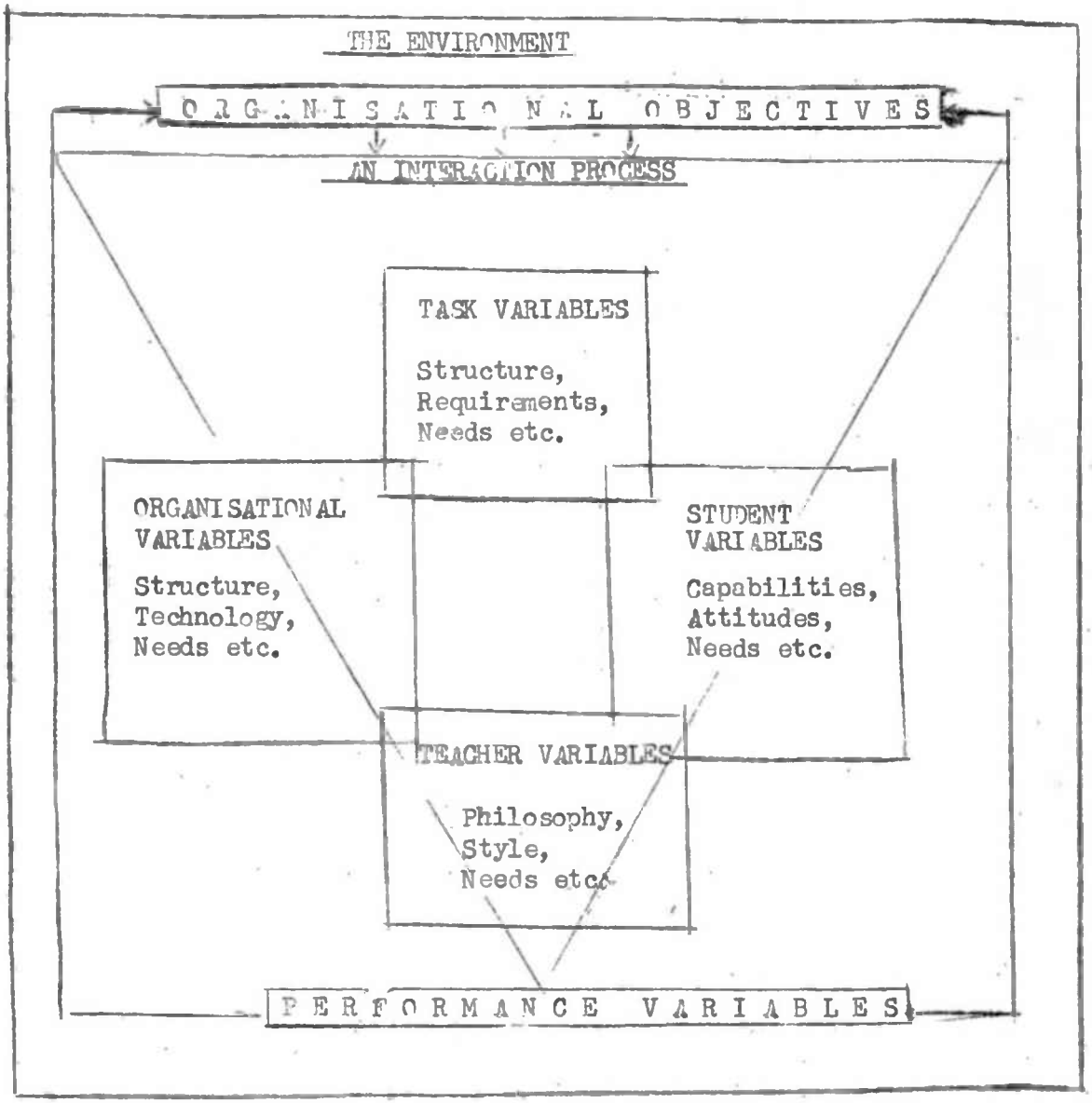
The teacher or lecturer is seen not only as a learning resource, but also as a manager of learning resources, able to balance and reconcile the conflicting task needs of the curriculum with the personal and group needs of his students.

Education, as we have seen, is concerned with change, for we are living in an environment that is constantly creating problems of obsolescence. Unfortunately, past patterns of organisation in education and training have tended to introduce a degree of rigidity and lack of flexibility that have made changes difficult to introduce or accept. Changes have been introduced, like programmes learning, and independent learning,-have t_ded to create new educational, social, and administrative problems, so that people have ultimately become disenchanted with them.

Modern organisation theory and its systems concept, on the other hand view change, innovation, and growth as the natural result of a concerted response to a new situation. Teachers are seen as managers of learning resources, charged with the role of choosing or deciding between alternative teaching and learning strategies.

Th· distinctiv qualities of modern organisation theory are : its conceptual-analytical base, its reliance or empirical research data, and above all, its synthesizing, integrating nature. These are all framed in an overall philosophy that believes that the only meaningful way of looking at organization is to study it as a system, and such a view is largely new at education and trading. A more meaningful approach is to take a whole view, both task and humna of thelearning system, and to determine how each of the many constituent parts interact with each other.

FIG : EDUCATIONAL TECHNOLOGY



Isolated parts can rarely provide adequate information about a system, but a system can provide valuable information about the functions fulfilled by each of its components. Such an approach is nothing, more than an application of the Gestalt concept.

Educational Technology : A theory of teaching :

Educational technology combining both the hardware and the software approaches of the other two technologies, build a bridge between educational theory and practice. As a result there is beginning to emerge an associated general theory of teaching, a guide to pedagogy, so that we need no longer be overdependent upon a theory of learning. Bruner characterizes such a theory of teaching as one that sets forth rules concerning the most efficient way of achieving knowledge, skill, or attitudes, and he considers that these rules should be derived from a more general view of learning. Educational technology provides the necessary conceptual framework for this new approach and helps to ameliorate the problems stemming from the needs of an education or training system to service, grow and develop the capacity to adapt and to manage change.

The teacher/lecturer -manager :

The concept of a teacher-manager with the four functions of planning, organisation, controlling and leading, offers a degree of renewned professionalism to a teacher and instructor, At the same time it provides for the possibility of improving the overall effectiveness and quality of a student's learning experiences. Three factors are particularly important in terms of this contribution: defining learning objectives, choosing appropriate teaching strategies, and assessing the success of the system in realizing its objectives.

This management approach towards learning, and teaching resources provide both a physiology and a pathology for education and training, for which learning prescriptions can be written. Just as medicine has moved its emphasis away from the treatment to the prevention of disease, so education and training can emphasize the prevention rather than treatment of learning problems and failures.

Teachers and lecturers must ensure that their thinking is contemporary with opportunity and not limited by out of date patterns belonging to past education and training practices.

Viewed from the management approach it is possible to isolate and identify the four broad functions that characterize the work of a teacher-manager :

1. Planning : This is the work a teacher does to establish learning objectives,

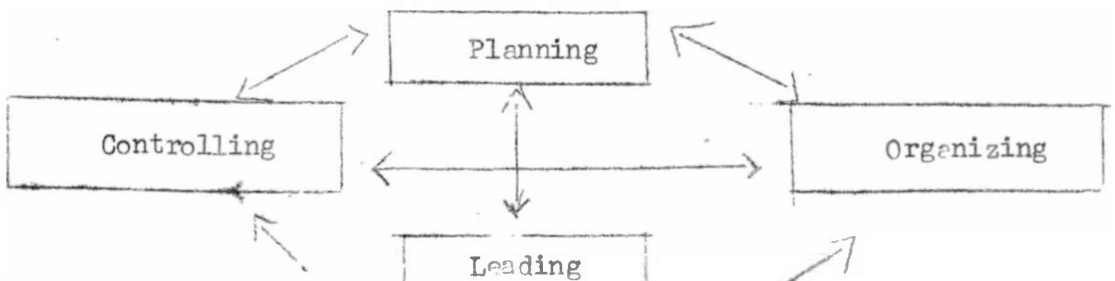
2. Organising: This is the work a teacher does to arrange and relate learning resources, so as to realize these objectives in the most effective, efficient and economical;

3. Leading : This is the work a teacher does to motivate, encourage, and inspire his students, so that they will readily realize learning objectives;

4. Controlling : This is the work a teacher does to determine whether his organising and leading functions are successfully realizing the objectives which have been set. If the objectives arenot being realized, then the teacher must reassess and regulate the situation - not change his objectives.

Although these four managerial functions are separate and disparate activities, they must be viewed as a cycle of related activities. Together they define the specialized area of a teacher or lecturer's professional competence and expertise. Together they make up the education and training management process.

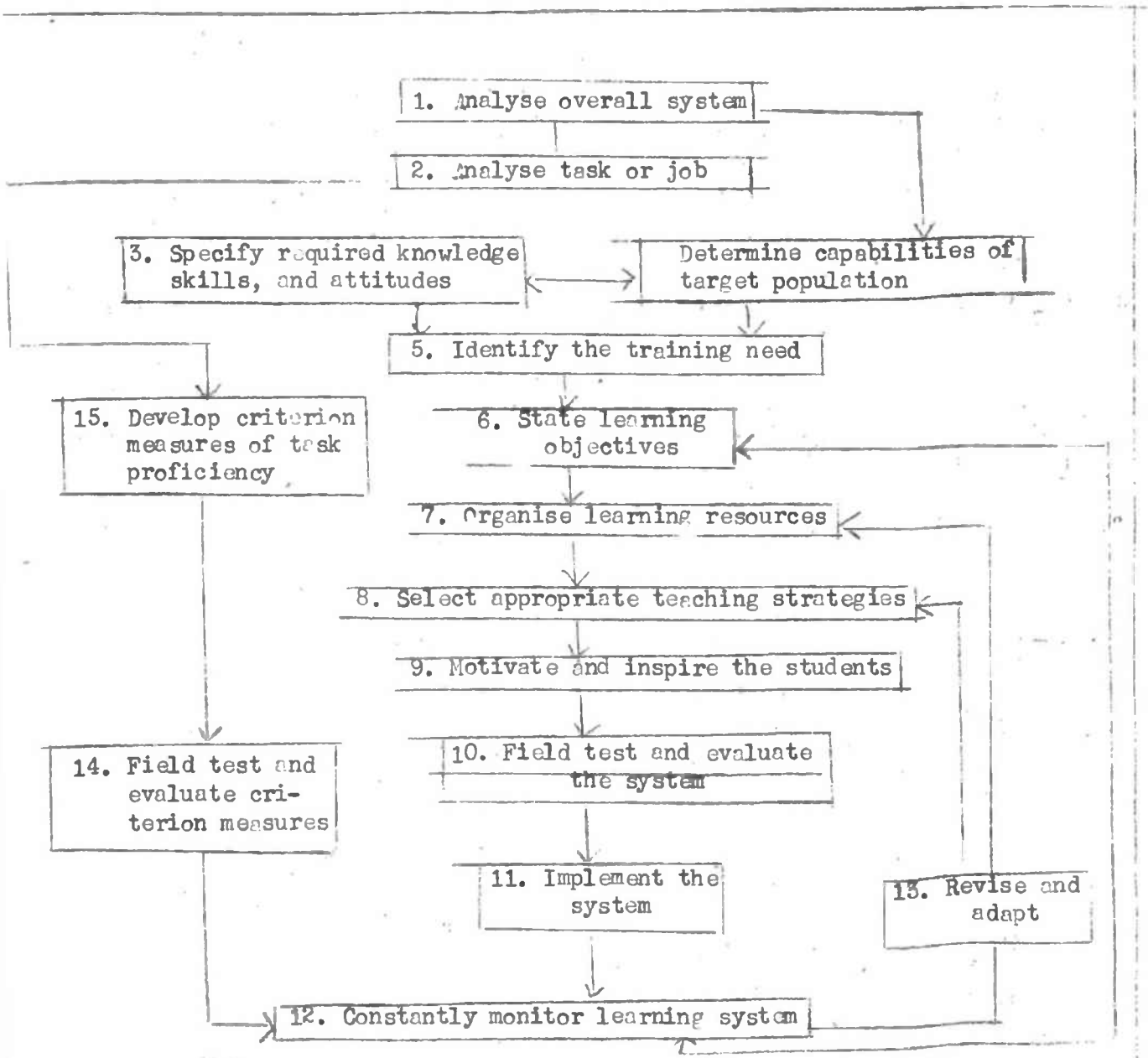
Fig:2 The four inter-related functions of the teacher-manager and training-manager:



The design of a learning system:

The philosophy of the teacher- anager introduces a further concept into education and training, which is of particular value in the design of a learning system. This is the conept of management by objective, which is related to the simple idea that a manager cannot exercise his four functions unless he is able to determine whether his students are successfully realizing the learning objectives that have been set for them. Once these objectives have been defined and the learning resources organised, the main concern of the teacher or instructor is to manage in terms of the results that are obtained.

Fig.3: The successive steps involved in developing a learning system.



1. Planning : involves activities 1,2,3,4,5,6 and 14,15 - defines the nature of the problem learning system has to overcome:

2. Organising : involves activities 7 and 11 - way in which resources are arranged:

3. Leading or direction:

involves activities 8 and 9 teacher adds to system to guide, help and inspire:

4. Controlling : involves activities 10 and 11 - valuating success in the learning system:

I. Planning function of the teacher - manager :

Planning is the work a teacher does to establish learning objectives. When a teacher-manager plans, he attempts to :

1. analyse the test;
2. identify the training need and
3. write the learning objectives;

In this way, he is able to forecast the learning requirements of the test, before he allocates the resources necessary to realize them.

1. Analysis of the Test:

One of the very first steps in developing an educational or training programme is to analyse the nature of the actual task involved. Some tasks are purely academic or intellectual in nature, others are primarily concerned with physical skills.

Regardless of the nature of the task, it is necessary to determine both the ingredients and the characteristics of the topics or job that the student has to learn. It is only when these precise characteristics are known that the training need can be established and the learning objectives written. For this reason great care must be exercised in carrying out the task analysis, for the ensuing document forms the basis of the learning prescriptions.

(a) Topic analysis: This involves a detailed analysis of intellectual tasks;
(b) Job analysis : This involves a detailed analysis of tasks involving physical or psychomotor skills, The techniques concentrate on what is done when the task is carried out. Job analysis involves such tasks as setting up a lathe.
(c) Skill analysis: This involves the further analysis of psychomotor tasks. But this time concentrating on how the job is accomplished. This involves intricate and subtle hand-eye coordinations.

As Mager has pointed out 'with the task steps identified in detail, we can better avoid the teaching trap of including more theory than necessary desirable, and deep the course performance oriented. Without this detail we might add hours or days of unnecessary theory.

2. Identifying a training need:

In the past there has been a tendency - particularly in industry to believe that education and training schemes are the most appropriate way of ensuring that performance is brought up to the required standards of proficiency. But as we have seen, there is more than one way as overcoming performance deficiencies and a point that courses on instructional technology tend to ignore. One of the more successful ways of deciding what training is necessary, is to decide what training is not necessary. This involves determining the actual character of any performance deficiency so that alternative

strategies, such as organizational change, can be considered.

3. Writing objectives: There is probably no single procedure in education and industrial training that is more important than writing learning objectives. What Gilbert has more accurately described as 'Prescribing the mastery responses'.

Stating objectives in performance terms, indicating the range of conditions under which performance is expected, and then defining acceptable levels of student performance, are important steps in educational methodology. Such an approach enables us to organise and explain the learning phenomena in a small number of precise statement, that these statements against actual experience, predict behaviour, appraise the soundness of decisions while they are still being made and help teachers and students to analyse their experience and so improve their performance. In this way, teachers and students are able to view evaluation as an integral part of the total learning system, rather than as an irrelevant chore to be accomplished as quickly as possible and then forgotten.

II. ORGANISING FUNCTION OF THE TEACHER-MANAGER :

Organising is the work a teacher does to arrange and relate learning resources, so as to realize agreed learning objectives in the most effective, efficient and economical way possible. When a teacher-manager organizes he attempts to:

1. select an appropriate teaching tactic;
2. select appropriate audiovisual learning aids;
3. select an appropriate class size;
4. select an appropriate strategy for communicating complex rules, procedures and instructions;

In this way the teacher manager is able to create the optimal learning environment for realizing the objectives of the education or training.

1. Selecting an appropriate teaching tactic:

The purpose of teaching is to bring about a desired change in the learner's behaviour. Teaching should make a student different in terms of what he can do or accomplish. The task analysis and learning objectives constitute a prescription for learning. They prescribe, in effect what has to be accomplished. In order to bring these changesabout teachers have to follow:

(a) teaching strategies
(b) teaching tactics

The problem of selecting an optimal teaching and learning tactic can be made against the basic criterion of the learning structure or objective to be realized. Such a view looks upon teaching from a new direction. The teacher is seen as a manager of learning tactics and strategies, tasked with restructuring the student's cognitive behaviour. The present approach which emphasise the structural properties of the task, offers something of a model against which important decisions can be made.

2. Selecting appropriate audiovisual learning aids:

Once the learning objectives and the subject matter structures have been carefully isolated and identified, teachers are in a much better position to select those audiovisual materials that are most likely to help their students reach the required levels of mastery.

Cognitive objectives can be realized by all A.V.Materials. Affective objectives are best realized by audio aids, pictures, films and television, simulators and language laboratories. Psychomotor objectives are best realized by audio aids, large models of reality; simulators and language laboratories; field excursions and visits.

3. Selecting an appropriate class size:

The pressure on education and training resources is now acute, so that the problem of determining the optimum size for a class or learning group has become a pressing one. The size of the class seems to depend upon the optimum inter-relation of syllabus training patterns and cell splits, as well as teacher-manning requirements, equipment availability, programming difficulties, and the physical size of the classrooms. The optimum class size is determined by the number of people a teacher must organise, lead, and control, so as to realize the learning objectives of the task.

4. Selecting an appropriate strategy for communicating complex rules and instructions:

Systematic decision making and problem solving are becoming increasingly characteristic of many education and training programmes. The problem is essentially a communication one, it has often been wrongly diagnosed as a learning difficulty and training has been accordingly lengthened. Replacing continuous prose, however, with job aids such as heuristics, algorithms, an and decision tables have usually reduced the problem and diminished the need for formal instruction.

III. THE LEADING OR DIRECTING FUNCTION OF THE TEACHER-MANAGER:

The leading is the work a teacher does to motivate, encourage and guide students, so that they will readily realize agreed learning objectives.

When a teacher-manager leads or directs he attempts to :

1. harness student motivation
2. select an appropriate teaching strategy for all ages so as to realize cognitive, affective and psychomotor objectives ;

Leadership is an aspect of organisation. A leader by his very position, is obliged to be effective and his effectivess depends to a large extent upon his sensitivity and style. He must balance the needs of the learner and the demands of the learning task and still get the right things done.

1. Harnessing student motivation: Motivation is the hidden force within us which impels us to behave in a particular way. All too often we have tended to motivate students by appealing to their basic needs and thereby imposing extrinsic forms of motivation and encouragement. These involve only one of the many strategies available to teachers and instructors and students need for autonomy and self actualization have been largely ignored mainly because it has not been readily apparent how learning tasks can be organised so as to realize them for a majority of students. Enrichment involves the fundamental quality of the learning experience and is therefore a key concept in the harnessing of student motivation.

2. Identifying an appropriate teaching strategy : The style the teacher adopts will have a great deal to do with the ultimate success that his students experience in learning. Some of the strategies are: lecturer method, lesson demonstration method, group discussion methods, Tutorials, Roleplaying, case studiesand games, brain stroming, programmed learning and computer assisted instruction, independent study, leaderless groups and sensitivity training; :

The strategy used in sensitivity training is :

(a) to increase the ability to appreciate how others react to one's own behaviour

(b) to increase the ability to gauge the state of relationships between others

(c) to increase the ability to carry out skillfully the behaviour required by the situation. Sensitivity training sometimes called 'T' group training, laboratory training, or group dynamics is a technique which employs group participation in such a way as to help participants become aware of how they affect others and others affect them.

TEACHING PSYCHOMOTOR SKILLS:

Every job has both a knowledge and skill component a knowing and a doing side. While the relative proportion of these two components will vary from task to task, skills analysis over a wide range of jobs suggests that certain industrial skills have similar structural characteristics or properties. Teaching the skill content of any job largely involve getting the student to do things, and this means that a teacher must exercise five broad responsibilities:

(a) he must demonstrate the skill to trainees as a complete cycle of operations;

(b) he must break down the skill into related, but separate sub-routines and demonstrate these just as a skilled worker would perform them;

(c) he must tell, and then show, trainees how a skilled worker actually obtains his results;

(d) he must allow trainees to continuously practise each of these subroutines until they learn the skill beyond the criterion.

(e) he must then ensure that these subroutines are chained together (retrogressively and progressively) and the complete skill overlearned through constant practice.

Performance on psychomotor tasks is largely a function of the habits and skills acquired on the task itself.

THE CONTROLLING FUNCTION OF THE TEACHER-MANAGER

Controlling is the work a teacher does to determine whether his organising and leading functions aresuccessfully realizing the objectives which have been set. If the objectives are not being realized, then a teacher must reassess and regulate the situation.

When a teacher-manager regulates or controls he attempts to:

(a) evaluate the learning system
(b) measure learning
(c) manage by learning objectives

In this way, the teacher-manager tries to determine whether events conform to plans, and to change failure into success; only his effectiveness can convert resources into results.

1. Evaluating a learning course: Examinations can also be allies in the battle to improve curriculum and teaching and such an approach is backwash effect of the examinations.

Such an approach underlines the importance of properly constructed criterion tests. Not only are they measuring instruments, but, in a real sense, they are also aids to improving the overall quality of learning experiences.

2. Measuring Learning: Much of the difficulty in most evaluation studies seems to stem from the nature of the measurements taken, the assumptions that are made and the selection of the test statistics for use in the subsequent analysis.

3. Managing by learning objectives : Management by objectives is a process whereby the superior and subordinate managers of an organisation jointly identify its common goals define each individual's major areas of responsibility in terms of the results expected of him and use these measures as guides for operating the unit and assessing the contribution of each of its members.

The application of management by learning objectives to education and training enables objectives to be related to the decisions that teachers and students make in a learning environment.

In the context of learning and training, Management by objectives consists of a continuous process involving four main areas of action:

1. setting organisational aims and objectives, and then deriving subject and topic objectives;
2. writing a learning guide or prescription, which also includes information on key results and performance standards;
3. Agreeing a learning improvement plan with each student;
4. systematically reviewing each student's performance and then counselling him so that he can overcome his weakness, build on strength and accept responsibility for self development;

The proper use of human resources:

The application of management by learning objectives to education and training enables the objectives to be related to the decisions that the teachers and students make in a learning environ-ment.

@@@@@@@@@@@@@@

1. Would it be technical if we plan to train an engineer who is generally wellversed with rudiment of all the basic 3 or 4 engineering branches. If this is so, would 4 years be necessary, can be think of making a general engineer within 3 years out of the 4 years course so that next year would be used in a particular field of specialisation.

2. Can we think of engineering degree itself as made up of two types one terminating at the end of 3 years which is meant for only maintenance works where as a full course graduates of 4 years duration meant for the specialised fields of R & D, higher study etc., or shall we say that we totally reconstruct our education programme, planned at end of every 5 years taking into account the needs of the country in specific fields. For Eg. Shall we plan "maintenance engineers" for the departments of Mechanical, Electrical, and Civil Engineering, the specific needs of whom for the next 5 years or so are given to us in advance. Then should these students be trained by us either by a University as a whole or by a few a few institutions of the Universities? So that these graduates are suitable for absorption immediately after the training. Shall we again think in terms of a few design engineers and a few more control engineers or a few Electronics designers, communication specialists - the list can be really expanded i.e., the needs of the country are basically of the developmental activities planned both in the public and private sectors for a time bound programme of 5 to 10 years. After all the purpose of the University is to train suitable graduates to fit into the requirements of these enterprises. Thus we note that our future mode of education is to change and the change needed is open ended. There-fore 'plan' for future technical education is not regid but has a wide choice of planning.

Some of the points not covered in the paper but need discussions include the following:

1. Train the Engineering student in the field while to is studying practical training as an integral part of the study.
2. Educate the Educator - Refresher courses to the teachers in the field of Education.
3. Educate the Engineer - short term courses for field engineers to acquirt them about latest innovations in their fields of specialisation.
4. Continuous monitoring of the system of Education - Dynamic curricula.

MODULAR SYSTEM OF TRAINING

- By Sachchidananda Ray
Ex-Assistant Director of Trai
CSTARI Calcutta.

INTRODUCTION:

Vocational Training programmes are being conducted by providing off-the-job training at the Industrial Training Institutes and Industrial Training Centres with the following objectives in view:-

i) To ensure a steady flow of skilled workers in different trades to the industries.

ii) To raise the quantity and quality of Industrial Production by Systematic Training of skilled workers.

iii) To reduce unemployment among the educated youth.

The craftsmen training scheme under the existing pattern of training has successfully served the industries in supplying well trained skilled workers to satisfy their needs. As the Vocational Training constitute the main stream of production of skilled workers in the country, it becomes imperative that the training keeps pace with the industrial requirements so as to increase the adaptability of trained work force. The present trend of rapid advancements in the field of science and Technology is constantly causing an ever changing occupational profile of industrial skills. Such a change or shift of industrial skills has to be met by the vocational trainin to fulfil the current and new emerging industrial needs.

In order to ensure that the Vocational Training programmes are developed up directly oriented towards the skill competencies require for the jobs in the industries and thus increasing the employment potential of the craftsmen, a task force was set up by the Planning Commission.

In October 1973, the task force recommended that integrated training programmes incorporating both off-the-job training and on-the-job training should be introduced in selected ITIs after ascertaining the skill requirements of industries. The training programmes to be introduced in the selective ITIs should be formulate after conducting qualitative skill survey of the industries in the region. The selective ITIs should be responsible for imparting the required training for attainment special skills identified through the survey, besides the basic training. The Training Programme in special skill areas has been recommended to be conducted in 'Modular form'. A Training Module is a self contained entity containing speci

skills alongwith the related knowledge within a well defined occupation to enable the workers to attain the skills and related knowledge to improve their employment standard and/or to obtain gainful employment If these training facilities can not be provided in the ITIs due to economic reasons, the modular training in such special areas would be conducted in the ITCs.

Thus, the modular system of training enables the trainees to learn the skills and related knowledge which has immediate value in their employment and makes them readily acceptable to the industries. This system also takes into account the changes of skill profile of skilled worker due to technological or other changes and enables the skilled workers to make up their deficiencies by learning a fresh training module or modules.

The recommended training module is prepared by Qualitative Skill Surveys and identifying the special skill areas in the industries. By critically analysing the skills involved in a job of defined occupational area, the required training module or modules can be suggested to meet the skill requirements of the industries.

Preparation of Module:

A module consxisting of employable skills is a training programme through which a person obtains very precise training by virtue of which he can secure a job. Therefore, the basis for preparation of a training module is the job in occupational area. Hence, all the learning materials have to be derived from the job. All these learning materials must lead towards the development of those skills which will enable a person to do a job effectively and efficiently. The steps in preparation of learning material in modular form is as follows:

i) Identification of a job in occupational area.
ii) Division of Jobs into functions.
iii) Division of functions into tasks.
iv) Division of tasks into task elements/operations/skills.
v) Identification of concepts to be learned to acquire the skills.
vi) Creation of learning elements, concept by concept.
vii) Combination of learning elements into learning packages (Modules) reflecting -
   (a) Technical variables (b) trainee variables
   (c) job variables.
viii) Test and revise.

A training programme based on a module of employable skill is delivered through one or more learning packages containing an appropriate selection of learning elements resulting in acquisition of the required skills which are accepted by the employer or which can lead to self-employment.

Identification of Job:

Job in an occupational area can be identified by the following methods:-

a) Through man-power survey
b) By studying International Standard classification of occupations with Validation Directorate of Employment and Training.
c) By studying Wage Board job classification
d) By surveying industrial establishments about their products and nature of work done by their employees.

Division of jobs into functions and functions into tasks

It is difficult to have precise definitions either for JOB or FUNCTION or TASK. It may become evident that "REPLACING A TELEVISION PICTURE TUBE" for one worker be a task, for another worker a function, for another worker a job. Hence, it is necessary to have opinions of workers, supervisors, managers and the employer by personal interview for clear-cut definition job, function and task. Prior to the commencement of the interview, the persons concerned must be briefed about the purpose of the interview so that they put their opinion frankly and fearlessly and the record of the conversation must be shown to the interviewee after the discussion is over.

Division of Tasks into Skills:

The outcome of the interview will certainly give a list of acceptable jobs, functions and tasks. Each of these tasks can be broken down into very small steps. Each step represents an action or series of actions which is part of completing the task. These steps to perform a task is called as task elements or operations or skills as illustrated below.

JOB : Office Assistant/Dealing Assistant/Personal Secretary.

Task: Opening a new file.

Skills: 1. Receive instructions or identifies a need to open a

Skills: (CONTD.)

2. Obtains a file cover
3. Obtains/allocates identification
4. Marks file with identification.
5. Enters details of the new file in file list
6. Indexes or cross references file.
7. Preparation of storage place in correct sequence.
8. Stores file.
9. Notifies concerned person about identification of new file.

These task elements or skills are variable factors depending on whether an alphabetical, numerical or chronological filing classification is used.

Selecting Learning Elements:

Having formulated the learning objectives, the task elements or skills which are common to different tasks must be combined into learning packages to achieve those objectives.

Identification of concepts to be learned to acquire skills:

By examining the task elements or skills, it becomes easier to identify the concepts to be learned to acquire the skills.

For each single concept, a learning element can be prepared containing all the essential theory, technical knowledge, applied calculation, graphic information, safety and hygiene and physical manipulation.

Creation of Learning Elements:

There are four main steps in writing of a learning element:

a) Determine very precisely the outcome of the element. What the trainee is expected to learn must be borne in mind while determining the essential learning.

b) Write the learning objectives in measurable behavioural term. Prepare a list of tools and equipment and learning aids required for training.

c) Design a progress check will measure the trainee's achievements.

d) Write the text to include essential theory, technical knowledge, applied calculation, graphic information, safety and hygiene and practical work for skill development.

Where necessary and possible, a check for instructor must be included to test the trainees' achievements. If necessary, instruction should be followed by demonstration for better attain-

Combining Learning Elements into Learning Packages:

The objective is to prepare a training programme which will develop the correct selection of skills and the correct level of skills which will be acceptable to an employer or will lead to a self-employment.

Therefore, appropriate learning elements must be selected by considering the following three points:

a) The level of trainee.
b) The appropriate coverage of technical variables.
c) The job specification.

If we are going to train craftsmen, Apprentices who must have a good theoretical as well as practical background should be selected so that they can cope up with any situation which may arise during their work - then all possible learning elements must be included in the learning package.

A learning package can only be constructed in consultation with the employing establishments or on the basis of an on-the-spot analysis of the actual training need.

If this is done properly then training programme will exactly match the job descriptions and will give complete coverage at an appropriate level of learning containing all essential elements.

In cases, where the job is very limited, completion of one learning package will lead to employability. This will be a one package module of employable skills. For complex jobs, there may be more than one learning package.

A module of employable skill may contain one or more learning package. Depending on the level of trainee and training, a learning package may consist of one or more learning elements.

Testing:

Each learning element will inevitably reflect certain choices made by the author. The format may be standardised, but the text and choice of illustration will vary from person to person.

Hence, every learning element and every learning package (module) mustpass through several tests and periods of revision to ensure that the objectives are achieved.

Applicability:

Training modules for occupations using universally applied skills and technologies are currently being developed centrally by ILO experts. After field testing and validation, these modules can be effectively used for training industrial workers. It should be kept in mind that some modules may need to be adapted to specific training requirements of particular industries.

Jobs which are not universal and are non-standard, training modules needs to be prepared for specific purpose to satisfy the need of the industry of the region.

Applicability with respect to different entry qualifications:

The modules of employable skills are equally applicable to secondary school certificate holder and to early school leaver because the system is based on "fixed achievement in a variable time". Therefore, the trainees irrespective of their entry behaviour, ca acquire requisite skills for some degree of employability even if all the modules are not completed. This may provide them with immediate employment or self employment. This will lead to the possibility of acquiring further skills through modules so as to enable the trainees to move laterally and vertically.

Applicability in Craftsmen Training Programme.

The Craftsmen training programmes are sometimes outdated, outmoded, inappropriate, too theoretical, too general and often in excess of those actually needed by workers in performing their routine work. But by using modular training system, the irrelevant content of traditional craftsmen training programmes can be eliminated and the duration of the training can be eliminated and the duration of the training can be substantially reduced and there will be qualitative improvement in attainment of skills.

Applicability in short term training programmes (updating, upgrading, refresher and retraining)

The modular system of training is not only applicable for pre-employment training of the worker and reduces the overall training period. But, this can also be imparted to a worker in stages throughout his working life so as to prepare him for a specific function or task of a job and to motivate him to learn further modules to update and upgrade his skill and knowledge. Acquisition of skills from different areas is possible and practicable through modules. This will make a worker or instructor fit for a number of jobs. Therefore, modular system of training can be profitably applied

Applicability in In-Plant Training:

In acquiring skills through traditional inplant training programmes, the trainee has to depend on the expertise of a skilled worker and his willingness to spare time and concentration. The industrial establishments do not give priority to impart best possible skills to the trainee at the cost of production. Under these circumstances self-paced learning techniques inherent in modular system of training is advantageous as the learning materials can be used individually and at appropriate times without loss of production.

Applicability in Rural Vocational Training

In rural areas there is plentry of scope for self-employment and the establishment of small scale industries. Modular system of Training can be effectively applied for development of polyvalent skills required in rural areas with the help of mobile training unit and village cooperatives. The modular units have to be developed on the basis of specific skill requirements of the region.

Applicability in Engineering Education:

The modular system of Training can also be effectively used in engineering education, specially in the area of surveying Engineering Drawing, Workshop Practice, Electrical Instruments, A-C machines, D-C machines, Instrumentation, Electronic Measurements, Heat Engines, Building Construction etc. But the modules have to be developed on the basis of skill requirements in consultation with level of trainee and the coverage of the technical variables and careful selection of learning materials.

Conclusion

It is essential for the training policy makers to understand that modular system of training can achieve maximum efficiency and effectiveness only when all the elements of the system are present. If the building and other facilities, the training staff and the tools and equipments required for the training programmes are not provided and if budgetary provisions have not been made for raw materials required for the training, then the modular system of training will be failure like other training programmes. There is, also a need, for close cooperation and active support from employers' and worker's organisation for effective implementation of the programme.

&&&&

APPENDIX - 1

FORMAT - A

(For General Information)

A.1. Name of the Establishment

A.2. Address

A.3. Standard Industrial Classification Code No.

Major Code No..... Minor Code No.....

A.4. Type of Production

A.5. Nature of Production Piece Work/Assembly/Mass Production.

A.6. Size of the Plant Small/Medium/Big

A.7. Total No. of Persons Employed.....

A.8. Total No. of Workers Employed

Highly Skilled .....

Skilled .....

Semi Skilled .....

Any other Category.....

A.9. Sector ..... Public/Private

FORMAT - B

(For Identifying Training Areas)

B - 1 **Information regarding the Workers required to be trained in special skills**

Sl. No.	Occupation/ Trades for which Workers are required to be trained in special skills.	Grade/ Level of work within the occupation/ trade (Mention Category)	No. required to be trained	Prescribed Minimum Qualifications			
				Educational	Technical	Experience	Any other Special

FORMAT - B (Contd)

B - 2 **Information regarding apprentices**

Sl. No.	Trade	Nos. required to be trained as per Act	Nos. Actually under Trg.		Probable changes due to expansion/ diversification by	
			Fresher	Ex-ITI	1976	1979

FORMAT - C

Information regarding job description
(specified by the establishment)

Trade (Job) ..... Job description: Attach a Copy.....

Sl. No.	Grade	List of functions involved within the job	Remarks

FORMAT - D.

Test Analysis.

Trade/Job. . . . . .

Interview/Observation/Discussion

Function. . . . . .

Item	Description of task	Working ACC.	Frequency	Criticality	Difficulty

rsk/-

FORMAT - D (Contd.)

Item	Machines & Equipments used	Materials used	Tools & Instruments used	Remarks if a

FORMAT - E

Skill Analysis

Trade/Job . . . . . .
Function . . . . . .
Task . . . . . .

Item	Description of skill	Type of skill	Teaching Method	Equipment

FORMAT - F

Curriculum Development

Trade/Job .....

Function .....

Skill Item	Trade Theory	Workshop Calculation and Science	Engineering Drawing
1	2	3	4

JOB : ELECTRICIAN

Function No.	List of functions
1.1	Maintenance of Batteries
1.2	Maintenance of Lighting System
1.3	Repair and Maintenance of Motors
1.4	Repair and Maintenance of Starters
1.5	Maintenance and Repair of Transformers
1.6	Rewinding of Armature
1.7	Rewinding of Stator
1.8	Rewinding of Instrument Transformer
1.9	Checking and Repair of Electrical Instrument : Ammeter/Voltmeter
1.10	Checking and Repair of Electrical Instrument : Energy Meter
1.11	Checking and Repair of Electrical Instrument : Megger
1.12	Checking and Repair of Electrical Instruments : Centrifuge
1.13	Checking and Repair of Electrical Instruments : Control Switch
1.14	Repair and Maintenance of Relay
1.15	Maintenance of Circuit Breaker
1.16	Maintenance of Panel Board
1.17	Cable jointing

FUNCTION : 1.2 - MAINTENANCE OF LIGHTING SYSTEM

SL. NO.	TASKS INVOLVED	SKILL NO.	SKILLS/OPERATIONS INVOLVED
1	2	3	4
1.	Repair of line faul	1.01	Reading the main distribution layout drawing on receival of lighting complaint.
		.02	Isolating the faulty line from the mains by switching off the line distribution switch.
		1.03	Removing the fuse units away.
		1.04	Keeping a caution board on the switch with instructions: Do not operatte the switch. Line is under repair.
		1.05	Checking the mains supply by means of voltmeter to ensure the rated voltage at incoming side of the switch.
		1.06	Asseratining deadness of the isolated line by means of test lamp or tester.
		1.07	Checking fuse cartridges for correct fuse wire.
		1.08	Cleaning dirty contacts by sand paper and tighterning the connecting screws of the switch and distribution Board.

TRADE THEORY	W/SHOP CAL. AND SCIENCE	ENGINEERING DRAWING	EQUIPMENT NEEDED
5	6	7	8
Hand tools - their use and care. Electrical safety precautions. Fire fighting, First aid, Artificial respiration. Electricity regulations. Description of different electrical fittings and accessories main switches, distribution board, fuses, cut out, switches, lamp holders, plugs, joint boxes, push buttons, ceiling roses, reflectors/shades, light fittings. Different types of	Use of switches and fuses, conductors. and insulators. Common fractions addition substraction, multiplication and division. Decimals addition, substraction, multiplication. Conversion from fractions to decimals and vice versa. Applied workshop problems involving addition, substraction, multiplication and division. Properties & uses of copper, aluminium solder, timber and rubber.	Free hand sketching of common hand tools Sketching circuit symbols. Freehand sketching of lighting circuits. Blue print reading.	Wire gauge, Knives, Cable strippers, Hammers Screw drivers Bradawls Pliers, Woodsaws. Plaster saw Wood Chisel Cold chisel Rawlplug dr Hand Drill, Breast drill Angers, Trowel, Spirit leve Folding rul plumb line, Megger, Test lamp, Pocket test Main switch Distributio boards, Fuses, Cut out, Sw- La-

.....2/-

2	3	4	5	6	7	8
	1.09	Replacement of broken fuse cartridges and changing the fuse wire.	cables - PVC insulated, and sheathed, TRS, MICS, MLAS, PILSA etc. and their uses. Types and sizes of conduits-uses. Position of main switch, distribution board, ex switch and lighting fixture. Estimation of materials for wiring circuit. Use of reference books and tables. Wiring in workshop, factories and houses, purpose of earthing. Various methods of earthing.	Metric system conversion factors. Uses of Megger.		Plugs, Joint boxes, Push buttons Reflectors Light fittings Cables, Conduits, Earthing wire, Earthing rod, Earthing plate Char coal.
	1.10	Checking and tightening the ling-screw of return path.				
	1.11	Tracing the circuit layout with the help of cirucit diagram.				
	1.12	Testing the continuity of wires through conduit section wise to locate fault.				
	1.13	Measuring insulation resistance of the circuit by megger.				
	1.14	Replacing the faulty wire/s by means of new wire/s.	Fluorescent tube fittings their construction. Characteristics, available wattage, connection diagram etc. Rheostats, chokes and capacitors used in lighting fixtures and their applicability.	Use of logarithmic table for multiplication and division.	Free hand sketching of circuit diagram.	Electricians' common hand tools. Megger.
	1.15	Measuring insulation resistance of the circuit again for record.				
	1.16	Testing all single pole and double pole switches and outlet points in the circuit for continuity by means of megger				
7.	Operating/checking switch tuggles by hand to ascertain spring function.					
8.	Changing the faulty switch.					
9.	Checking the continuity of circuit.					

Summer School on Methodology of Teaching and Training
for the staff of the Engineering Colleges.

J C E COLLEGE OF ENGINEERING & REGIONAL COLLEGE OF EDUCATION
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TO EXAMINE OR NOT TO EXAMINE?

Dr.K.N. Tantry

Teaching has its own pleasure and pains. The most painful part to be played by a teacher is when he has to evaluate his students. Evaluation poses painful problems to the teachers. There is no choice left to the teachers but to become highly objective. Evaluation is an essential precondition for assigning grades. The future plans and prospects of his students depend upon the result of this crucial act of the teacher. Carelessness or lethargy during evaluation have shattered the hopes and aspirations of many young men and women in our country. Though the present examination system has been subjected to the most severe ridicule and criticism, the need for an examination as a tool of learning has not decreased over these years. Evaluation has been so much disabused by dishonest teachers during the past 2-3 decades, that it is being very seriously doubted in many educational circles, whether the system has any merit in it at all.

Apart from the fact that evaluation is a tool to grade students according to their mental ability, teachers should consider it as a very convincing evidence of the strength and weaknesses of their own instructional competence.

A basic defect in the highly objective type of evaluation is the fact this technique does not treat its "victims" as human beings at all. It sets a uniform high standard and no matter what hard and honest work has gone behind in trying to reach that standard by an individual, it puts him down mercilessly as an underachiever if he does not 'reach' that standard. A bright and lazy student might have reached it by a casual study while the one who has struggled day and night from a very low level might have missed it very narrowly. Should there no reward for the honest students? The objective assessment by a teacher on the performance of these two individuals would perhaps destroy the yearning for learning by the so-called underachievers. Yet our examination system has no solution for this type of problem. However, knowing its limitation, we can look at the whole evaluation system objectively and look for ways and means of plugging the loopholes of the system.

How and how not to evaluate?

Absolute honesty: I am not at all suggesting even remotely that teachers are dishonest. Nor do I mean that deliberately

a teacher will punish his students by giving a very difficult test. But even if unintentionally students are graded wrongly the student is the sufferer. It is always essential for a student to know what is he expected to learn and what the teacher is going to test. The objectives of learning and testing ought to be identical and both the teacher and the students should be aware of it so that they would both be working towards achieving the same goal. Imagine the performance of a team of hockey players not knowing at which goal they are expected to hit the ball to score. There is the famous study report of a class of marine engineers whose performances were bad in the first test, better in the second, good in the third and very bad in the final. The study showed that the students who were tested by a teacher in the first test were unaware of the evaluation procedure and objectives of their teacher and did badly. In successive tests they showed remarkable improvement as they gained familiarity with his techniques. The final test was by an entirely different person whose objectives and evaluation criteria were entirely new and unexpected. A very honest evaluation procedure is one when the teaching and learning objectives are very clearly known to the teacher and the learner.

Frequency: Dependence on a single or two evaluations as a yeardstick to judge an individual's ability is unethical. There are very many variables which influence the performance levels of students who are being evaluated. Surprise test or

test by teachers of different subjects all within a short span of time, would result in poor performance by many students. A very large number of evaluations too, is unhealthy. A compromise is needed. As evaluations help both the teacher and the learner, it would be good practice to have evaluation done at the end of every unit. Such evaluations help the student to warn him of his shortcomings and act as danger signals for lazy students.

When instruction is through programmed learning techniques, evaluation is in-built in the system itself as a student would not proceed further till he is mentally sure of his level of learning. In fact, there is continuous and persistence check at every point of learning. No wonder then that those who are too sensitive give up learning altogether, due to this 'nagging' evaluation.

Variety: The word "examination" strikes terror in the hearts of young and old. Many, who in their later life, proved 'genuises' were disgusted at this type of examination, which meant sitting through a 3 hours ordeal under scrutinising eyes of superintendents. But by far this is the most popular type of evaluation procedure followed all over the world.

Its advantages are:

1. That the same question or very few questions can be used to evaluate a very large number of students under exactly

similar sets of conditions. It is reasonable to assume that the grading would be unbiassed.

2. The time consumed in this type of evaluation is very little.

3. In these days of students' demand for a check on the teacher's objective assessment, the written answers can be used as proof of their performance.

4. The evaluation item may be prepared well in advance or stored in the form of question bank and retrieved depending upon the type of objective or question needed for testing.

5. The test could be adopted for checking both the breadth and depth of students' mastry of a subject.

6. It is easy to construct.

These are the important advantages, especially, the last one, mentioned above, Hence many teachers resent the very idea of changing from this types of 'paper and pencil tests'.

However, we should bear in mind the fact that we learn more things outside the classroom than inside. We evaluate the clothes we buy, the food that we eat, the articles that we purchase the friends that we have, not by facing such a written test. We use other techniques and they too are equally convincing.

Skills are best evaluated by asking a student to demonstrate them, value judgements can be tested by elicitation

or informal discussion, leadership qualities are tested by group work; creative abilities are evidenced by writing or other, over manifestation s like models, charts, instructional materials. There are perhaps as many techniques of evaluation as there are behaviours. There are some who can be brilliant leaders and others honest and handworking followers. The same tool for testing them would not bring out these latent qualities to lime-light.

Variety then, in evaluation, helps a teacher to spot the various covert manifestations. Surprise test, quiz tests, debates, brain storming sessions, open book tests, demonstration, preparation of charts, static and dynamic models etc. are all other useful was of evaluation, equally effective in grading students abilities.

Intent: We are aware of the consequences of erratic evaluation. Whether, we like it or not a grade card happens to be the entry permit for young men who enter the world from out of the gates of our colleges. The whole community views his grade card as an index of his true achievement. A biassed evaluation would dampen and hamper the prospect of a young men getting employed anywhere. Students become rebels and lose respect for the teachers.

All employers view a candidates grade card as an

accurate guide to the mental abilities and the skills he has developed during the course of his student career. It has thus to be scientifically documented and impartially presented. Systematic evaluation at regular intervals by a variety of techniques honestly to assess the knowledge and skills and additional relevant data regarding demonstrated effort and/or possibilities for useful remedial instruction should be the sole intent of all teachers in order to save the much maligned examination system from condemnation.

How useful is an evaluation?

An objective evaluation of a student should be truly reliable. Reliability is a measure of the probability that a student would achieve the same score if the same test is administered to him/her or how close the test scores are if the same student faces two equivalent forms of the test.

Another criteria for evaluation is its validity. Validity may be either of content validity or it may be predictive validity. By content validity we mean the evaluation instrument measures what the teacher wants to measure, be the content or the skill objective in question. Predictive validity is a measure of how well a pupil performs in a later test based upon his previous tests. Closer the correlation between the two, the higher the predictive validity.

TESTS

What Types?

We have answered the question 'why should we evaluate'? All our tests are intended to determine the students' abilities relative to the instructional objectives. This means we compare the students' performance with some well defined norms or criteria. Hence we call them Criterion-Referenced Evaluation(CRE). While discussing objectives we have taken great care to define them in terms of expected pupil behaviours in minimum acceptable standards. Hence such evaluations(CRE) are accurate instruments of detecting who can and who cannot reach these norms and how far away is the student from the set goals.

However, these tests are not able to give valid comparative data about an individual's performance. But if we would like to get a clear picture of every students' performance in relation to the performance levels of a group of students at about the same mental abilities(called the norming group) the type of evaluation is called 'Norm-Reference-Evaluation(NRE) (e.g. NSTS exam or entrance test for IIT-Medical Colleges etc.). The reliability of NRE's directly related to the size and homogeneity of the norming group and with the generality of knowledge and skills being tested. Generally NRE carry a wide range of test items differing in difficulty

levels so that the bright can be easily differentiated from those below average whereas in CRE's the items are of more less equaldifficulty level.

Standardised tests: There are commercial agencies which construct suitable test items based upon the needs of any special group.

These tests are so designed as to have-

1. high discrimination power,
2. high reliability index,
3. equivalent difficulty level for particular group of target students.
4. good biserial correlation

Detailed instructions are supplied not only in the administration of the test but also in the interpretation of the results of these tests. However, these tests are generally not always related directly to the classroom objectives. As such their content validity may be questioned. Teacher made tests are suitable tests for class room evaluation while standardised tests are for a large student target populations.

Standardised tests are classified into:

1. Intelligence tests
2. Diagonostic tests
3. Aptitude tests and
4. Achievement tests .

Open book tests: are intended to help a student check his ability to gather information from resource materials in a

limited time. What is being evaluated is not rote memory but his skill in locating the right answers from a number of relevant material in a limited time.

Take home tests: are extensions of open book tests where the students' abilities are tested by giving him a longer interval of time. The type of evaluation items are of higher levels, viz., application, analysis or synthesis.

****

E S S A Y T E S T

What types of test items?

Let us start with the most familiar teacher tests- Essay type. These are the easiest to set and that is why so popular. Its great advantage is that it demonstrates student's understanding of the relationship among a lot of information, as well as the total understanding of all the information on a topic. It is a single question which is expected to evaluate higher mental abilities like organising data, sequencing, interpreting, inferring etc., in the realm of synthesis and evaluation.

But the dis-advantages are many-

1. Objective evaluation of the essay is difficult as differen

evaluators grade the same essay differently and it is even known that the same examiner grades the same essay differently at different intervals of time.

2. Essay questions could be guessed. Those who succeed in guessing correctly get better grades than those who fail to correctly guess.

3. Those whose language is good and handwriting neat are normally graded higher than those who cannot write neatly and forcefully.

4. Objectives are not clear to students and they are likely to go astray.

Unless the essay questions are thoughfully prepared the reliability is poor. However, one can improve the essay type questions by...

1. Being unambiguous and not misleading the students, tell him what you expect and how much of it.

2. Give enough time for a student to organise the information. He is supposed to be conversant with the relevant data but requires time to present them well.

3. Do not have any preconceived notions about the students. Better not see who has written it but how has he written it.

4. Have a model answer and compare all answers with this model.

Short answer(Short Essay): Unlike the essay, the objectives are limited, the number of words or sentences are specified so

that the student is clear what and how much is expected of him.

Objective test:

1. Multiple Choice: We have talked about instructional objectives. The idea of evaluation is to confirm how many and how well these objectives have been achieved by a student and grade him accordingly. We have a variety of choices like, the multiple choice, matching, true and false, and completion items to select for the construction of objective type tests. Unlike the essay type test items, the teacher has to spend quite a bit of his time to construct an objective type test paper. He has to identify all the instructional objectives and if he wants to test the in-depth understanding of a students., must have a very large number of items at his command. The greatest advantage is that evaluation is less time consuming and highly objective.

Even the objection of its opponents that it is time consuming could be overcome by having a question bank with items for various objectives listed, for the content of the unit or units.

Multiple choice test items are quite useful because they can be constructed easily, to test cognitive skill ranging from simple recall to analysis.

Recall: Who should be held responsible for not formulating precise instructional objectives?

a. Principal
b. Teacher
c. Student
d. College Management
e. Dept. of Education

Application: A test performed by a group was as follows:-

),35,40,45,5,45, '7.5 The mode of the test score is-

A	42.5
B	47.5
C	35.0
D	45.0
E	40.33

Analysis: A Beckman thermometer issued to three students for a particular experiment was found broken at the end of the day. The students pleaded that they were not responsible as no one noticed the hairline crack which was perhaps there even when it was given to them. What should be teacher do in order to fix the responsibility for the breakage?

a. suspend the students till they tell the truth
b. fine all the three
c. check from the batch of the students who had used the experiment earlier.
d. let off the students as it was their first act of negligence.
e. check first the Lab. assisant, check from the previous batch of students separately, to decide whether to fine and then calculate about the quantum of fine to be imposed.

Construction of a good multiple choice item requires great care and experience.

True and False: It can be conveniently used for testing only the lower levels of learning. A major disadvantages is the high probability (50%) of guessing correctly.

It is necessary to bear certain key-points in the construction of such test items.

Matching: This too is generally capable of testing lowerlevels of learning skills such as recall or understanding. Some guide lines are to be borne in mind while preparing these items.

Completion: These items are most suitable for testing recall a key word or a phrase. It is the least used of the objective items. Better items could be prepared if we note some useful points.

Quick Reference Guidelines- Teacher-Made-Tests:

OBJECTIVE TESTS:

1. Advantages:

a. Provide a broad sampling of students' knowledge.
b. Present the same problems and the same alternative to each student.
c. Minimize the chance of student bluffing.
d. Can be scored quickly and with little, or no need for subjective decisions.
e. Items can be improved on the bais of item analysis.
f. Reliability can be increased through item improvement.

2. Dis-advantages:

a. Difficult to assess some cognitive skills, such as synthesis and creativity.
b. Increases the possibility of guessing.
c. Items take a relatively long time to construct.

3. Utilisation Factors:

A Construction and Administration:

1. keep the language simple,
2. ask students to apply, rather than simple recall information.
3. make sure each item is independent
4. do not establish or follow a pattern for correct responses.
5. do not include trick or trivial questions.
6. do not answer questions after the test has started unless you do so publicly.

B Multiple choice items:

1. put as much of the item as possible into the stem.
2. make all options reasonable
3. do not provide unintentional clues
4. avoid the use of all-inclusive or all exclusive terms.

C True/False items:

1. Be sure that each item as definitely true or definitely false.
2. avoid the use of all inclusive or all exclusive terms.
3. be sure that items are not dependent upon insignificant facts.
4. be sure that true items are not consistently longer or shorter than false items.
5. avoid the use of double negative and call attention to single negatives by underlining or capitalising the negative word.

D Matching items:

1. limit the number of items to be matched to ten or less.
2. make sure all items concern one topic.
3. have more answers than questions or stipulate that some answers can be used more than once.

E Completion items:

1. write items that can be completed with a single word of short phrase.
2. be sure that only one word or phrase can correctly complete the sentence.
3. put the blanks near the end of the sentences.

4. make all blanks the same length
5. do not put more than tw o blanks in any one item.

ESSAY TESTS:

1. Advantages:

a. emphasize high-level cognitive skills, such as synthesis and evaluation.
b. provide an in-depth sampling of students' knowledge of specific topic.
c. allow for student creativity, analysis, and synthesis skill assessment.
d. Easier to construct than objectives tests.

2. Dis-advantages:

a. reliability and validity tend to be lower than on objective tests.
b. biased in favour of students those who write well.
c. grading is time-consuming.
d. increase the possibility of bluffing.

3. Utilisation factors:

a. be definitive about what you expect from students.
b. make sure students have sufficient time and materials to do the job.
c. grade papers as anonymously as possible.
d. compare each response to a model response or to a list of crucial points.
e. do not mix essay items and objectives items on the same test.

WHAT TO DO AFTER TESTING?

The purpose of evaluation has been understood to assign grades to students. One of the methods available for grading is the 'curve' method. In this method one has to calculate the SD to begin with a fairly easy way of calculating SD is as follows:-

1. arrange the marks in the decreasing order of magnitude.

2. find the sum of the top one sixth as well the bottom one sixth.
3. subtract the latter from the former.
4. divide the difference by one half of the total number of students.

Imagine the following marks secured by a group of students:

90, 95, 85, 75, 75, 70, 70, 65, 65, 60 & 40.

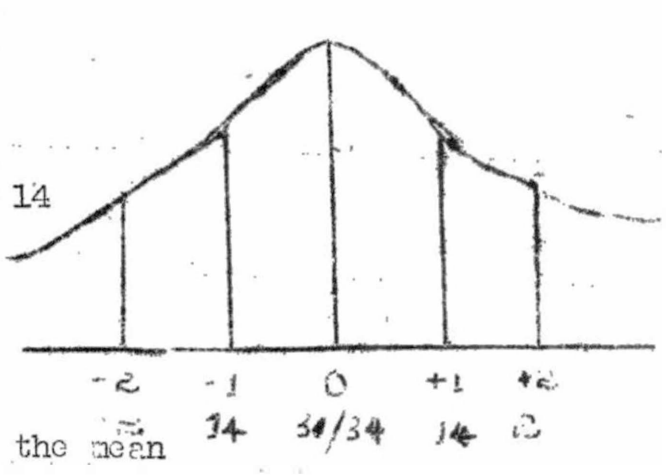
Let the grading be based on the scheme.

A = 1.25 SD or
B = 0.25 SD to 1.25
C = 1.0 SD to 0.25
D = 2.0 SD to 1.00
E = less than -2.0 SD

Approx. SD = $\frac{(95X90)-(60X40)}{6}$ = 14

Mean score = $\frac{\text{Total}}{\text{No. of students}}$

= $\frac{865}{12}$ = 72



A is any score above 1.25 SD of the mean

72+1.25 x 14 = 89.5

B is between 88 and 72 0.25 SD = 75.5

similarly we can calculate-

A = 89 or greater
B = 75-88
C = 58-74
D = 44-57
E = 43- or lower

Another interesting or more popular method of assigning grades is the "eyeball" method.

Consider the above example again, Four ways of looking as it are:-

100		100		100		100	A
95	1	95	1	95	A		
90	A	90	A				
85		85		90		95	B
80	B	80		85	B	90	
		75	B				
75		70		80		85	
70	C	65		75		80	
		60	C	70		75	
				65		70	
				60	C	65	
						60	C
65		55		55		55	
60	D	50	D	50		50	
		45		45		45	
55							
50							
45							
40		40		40	F	40	D
35	F	35	F	35		35	

In order to help a student and guide him, it is advisible to notify at the end of every test the model answers for the test. This is quite helpful to the new entrants to a college.

WHAT IS THE MECHANICS OF TEST CONSTRUCTION?

A well constructed test brings satisfaction to both the teacher and the learner. This can happen when the two are aware of the objectives of the course. The basic points to be borne in mind before constructing a test are...

1. the objectives of the course
2. the duration of the test
3. the distribution of the scores for the different levels of learning like knowledge, comprehension, application, skills, synthesis, analysis etc.
4. the need to discount guessing and selective study by students.
5. the allocation of scores for each test item.

These are best achieved by preparing a detailed blue-print for a test.

The teacher has to lookat the instructional objectives of the courses and the understanding levels of his studnets, based on these he has to decide upon a distribution of the total scores for the various levels of learning. A scheme of distribution for a course may look like the following:-

Knowledge	20 (K)
Comprehension	30 (C)
Application	30 (A)
Skills	20 (S)
Total =	100

He has to analyse the entire content in terms of specific behavioural outcomes brought about in his teaching course and classify them into knowledge, comprehension, application and skills developed.

He has to select from amongst these, those objectives which he feels are important from the point of final evaluation.

He has decide the types of questions he would be selecting for each of the content, objective, short answer or

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Li/

1. the objectives of the course
2. the duration of the test
3. the distribution of the scores for the different levels of learning like knowledge, comprehension, application, skills, synthesis, analysis etc.
4. the need to discount guessing and selective study by students.
5. the allocation of scores for each test item.

These are best achieved by preparing a detailed blue-print for a test.

The teacher has to lookat the instructional objectives of the courses and the understanding levels of his studnets, based on these he has to decide upon a distribution of the total scores for the various levels of learning. A scheme of distribution for a course may look like the following:-

Knowledge	20 (K)
Comprehension	30 (C)
Application	30 (A)
Skills	20 (S)
Total =	100

He has to analyse the entire content in terms of specific behavioural outcomes brought about in his teaching course and classify them into knowledge, comprehension, application and skills developed.

He has to select from amongst these, those objectives which he feels are important from the point of final evaluation.

He has decide the types of questions he would be selecting for each of the content, objective, short answer or

essay, under each level of learning.

He has to distribute the scores for each of the test items.

He has to check, carefully whether in the total allotment of time allotted, a student gets enough time to any answer each question and gets a few minutes for revision too.

He has to see that there is no scope for guessing and that only those who have studies the entire course get the credit and not those who have made only a selective study.

He has to prepare a key to the test and should ascertain that the time allotted is quite sufficient.

He has to give choices, it could be only internal choices rather than choice of content.

He has to check the questions to find out if they are ambiguous grammatically incorrect or contain clues to the answers.

He has to remember that the student is under tension and that teacher should help a student to exhibit his learnings and not a criminal to be pursued till he gives up.

A blue print has the general format:-----

Test..... Class.....

Time..... Marks.....

Teacher.....

Sl. No.	Instructional Objectives with content	Knowledge			Comprehension			Application			Skills			Time	Marks
		Obj	SA	E	Obj.	SA	E	Obj	SA	E	Obj	SA	E		
1.	To be able to descriminate														
2.	To be able to infer.....														
3.	To be able to recall.....														
4.	To be able to see relationship														
5.	.....														
6.	.....etc.														

Testing is not a process of punishing pupils at the end of a course. It is a scheme for awarding a satisfactory certificate to the pains taking effort of a pupil.

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ARE WE
REACHING
THRO'
TEACHING...?

I.S.T.E.
SUMMER SCHOOL
ON
METHODOLOGY OF
TEACHING AND
TRAINING

Regional College
of Education and
Sri Jayachamara-
jendra College o
Engineering,
MYSORE- 570 006.

METHODS
OF TEACHING
APPLIED PHYSICAL SCIENCES

(LECTURE NOTES)

-By Sri H.G.Ramachandra
Lecturer in Education,
K.S.E.F.College of Education,
TUMKUR - 572 101.

Today, teaching is compared to communication engineering. It is a cyclic process but, not a linear process in the present context of exploding information, a teacher can no longer confine himself to be a present of information. He should play the role of a manager of learning situations. As a co-ordinator of learning experiences, he should move towards maintaining a reflective atmosphere in his classrooms. And he has to strive for optimising technology of Education through an effective integration of

the need for integrating men, material and resources for optimising learning has to be realised by our teachers today.

Reforms in science teaching are now in the air. 'Science should be taught the scientific way' has been our slagan now. The growing emphasis in classroom practices in science should be shifted from learning to thinking. This requires a revolution in our approach to science teaching. To aim at realising "Scientific humanism"- a concept which involves a progress in technology in velation to our culfural, economic, social, spiritual, ethical and human values is very important. The aim of higher science education should not be an over - commitment to technology. Educational research in science teaching has not produced any one method of teaching which is best for developing all objectives.

EMPHASIS TO BE SHIFTED FROM TEACHING TO LEARNING

THINKING

THE NEED FOR AN INSTRUCTIONAL SYSTEM.

THE CRITERIA OF A GOOD INSTRUCTIONAL TECHNIQUE IN SCIENCE.

THE PSYCHOLOGICAL FOUNDATION

However, the difficulties encountered by most of the teachers in teaching sciences should also be borne in mind while evolving instructional strategies for better results. Some methods are more effective for skills than scientific knowledge the 'nature' 'interest' and the 'need' of the learners should underlie any method.

Since the areas of technology are graving in complexity and sophistication, the need for a good grounding in science, mathematics and communications becomes increasingly important in technical curricula. The subjects physics, chemistry, mathematics in technical education generally fail dismally to accomplish what is expected of them. Because of /this/ - plight of physical sciences in technical education, we should aim at planning a new and hopefully more effective pattern of teaching physical sciences. An insoirational, creative science teacher will make use of a variety of techniques in /providing/ the students with varied learning experiences

TOWARDS
DEVELOPING
INTELLECTUAL SKILL
TECHNICAL
COMPETENCE AND
SCIENTIFIC
ATTITUDE.....

RESEARCHES
ON
SCIENCE TEACHING
.....

in order to develop in them intellectual skill, technical competence and attitude. A dip in the Ganges of Piaget a great psychologist - makes every teacher sensitive to the strength and weaknesses in his techniques and procedures. The educational implication of Piaget's work in evolcing structures intellectual/development, Ausubel's researches, Gagne's view point, Bloom's mastery learning theory and so an have far reaching to consequences to our Science Education.

There have been a good number of studies which are directly and indirectly related to thinking and methods of science teaching. However, new studies in a wide frame of reference are urgently needed. Some of the outcomes of the many researches carried out in this regard have led to

TOWARDS
AN
INSTRUCTIONAL
SYSTEM .....

PATTERNS.....

some INSTRUCTIONAL SYSTEMS or methods of effective transmission Still. Lecture Method, Demonstration Method, Laboratory Method Problem soling approach, Project Method, Discussion Technique, Heuristic Method, Cantract and Historical Method have their place in science teaching at different levels.

Stanley Hall's study of the contents of the students' mind emphasises the importance of primary experience ratter than bookish knowledge. Banks studied the development of children's thought with the help of Demonstration experiments. Kniglak investigated some behaviour objectives for laboratory instruction. He stresed the heuristic method in the teaching of science. Charren George investigated the effect of open ended experiments on the achievement of certain objectives of science instruction. He followed the experimental design for this study. He concluded that experimental

THE CONSENSUS

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THE PHYSICS PROJECT LABORATORY AT MIT . . . . .

that each third of such a module would engage a student for about a week, and this scheme has the advantage that much can be learned by working with only the first two parts or even the first part of a module. The working group at the Edinburgh conference in 1975 were unanimously of the opinion that the barve notion of an experimental investigative pattern of learning physics showed high potential for effective utilisation in primary,, Secondary and tertiary education fields as well as in technical education scheme.

PHYSICS PROJECT LABORATORIES were started at MIT in 1964 on a pilot scale with about 50 students 2 faculty members and 2 Graduate Assistants. There will be 6 section of 24 - 26 each and one faculty member per section. This is 'Six hours a week' scheme and the students spend time in the lab. building apparatus, testing, measuring, taking data Their

TOWARDS
AN
INSTRUCTIONAL
SYSTEM .....

A FEW
PATTERNS.....

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critical thinking in Chemistry there are other studies which relave to the use and effectiveness of autio-usual aid in science teaching.

A MODULE ..... LABORATORY - CENTRED INVESTIGATIVE MODE OF TEACHING PHY. SCIENCES

The American institute of Physics which set up a National steering committee to plan a programme in this regard has contributed certain effective instructional systems that could be implemented at technical education centres. The consensus arrived at was that experimental experience would be more suitable for technical students than text book centred learning and this experimental experience should occur in a modular format.

The pattern of Laboratory - centred investigative mode of teaching physical sciences has implication that reach far beyond the relatively limited purooses of technical education. The work done at the Technical Education Research Center at Combridge, Massachusett , U.S.A. is

STEPS IN THE MODULE EVOLVED .....

really commendable in this regard. The general strategh for building module is as follows:

I PART - Giving a general, qualitative presentation of what will be going an in the module, introducing physical concepts.

II PART - To have the student make such measurements on the device in operation as are needed to disclose what is going on quantitatively and then dislay the results of his measurements graphically.

III PART - Taking the student into measurements and discussion that show (or are intended to show) what has been learned in the first two parts can be used to investigate and understand a broader range of phenomena than those which comprise the

THE CONSENSUS

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note books and discussion with them would enable the teachers to observe their progress during term. During the time for preparation, they go to the library, track down references, read the classies backgrand and study data. They also think about what to do next. There is a weekly lecture period at which 10-15 minute talks are given by each student concerning his project. The rest would form the audience one can see collective progress during the term in these meetings. Naturally, as usual, imagination, inventiveness, ability, and experience help - some exples, of Mechanical, electrical, optical and vacuum expts.

THE KELLER PLAN AT M.I.T.

THE KELLER PLAN AT MIT, a self-paced, student-tutored, mastery - oriented industrial system, has been a popular technique of teaching physics at MIT. The system uses lectures for motivation, instead of for transmission of information and uses them only

A

SELF - PACED,

STUDENT - TUTORED,

MASTERY - ORIENTED

INST. SYSTEM.....

Students proceed at their own paces, asking for unit achievement tests when they feel ready. Failing a test means only a delay; the material must be restudied and another test taken an the same material. Students take as many as 3 tests per week if they wish. Here, we should distingnish between teaching and the transmission of information - the student must do his part and the teacher must evaluate and respard to the students' efforts. The student is an active element in a process, not merely a receiver of information - THE PROCTOR, ASSISTANT AND INSTRUCTOR.

AND THE

OTHER

APPROACHES

.....

Of course, INTER-DISCIPLINARY APPROACH in science teaching, DISCOVERY APPROACH, HISTORICAL METHOD, LECTURE - CUM - DEMONSTRATION and so on are the other instructional techniques in science Education.

THE

CREATIVE,

INSPIRATIONAL

SCINCE

TEACHER

.....

Attempts toward evoluing a systems approach in teaching are gaining momentum.

In spite of individual differences, a teacher is expected to guide each individual in the directions pointed out by the outcomes sought. We can conclude with CARLETON saying -

"THE SCIENCE TEACHER GETS HIS JOB DONE ONLY BY WHAT HE INDUCES, MOTIVATES, CAJOLES, INSPIRES, FORCES, OR CHALLENGES HIS STUDENTS TO DO, AND TO DO IN SUCH A WAY THAT THEY LEARN. THE MISUSE OR OVERUSE OF CERTAIN METHODS IS ONE OF THE HAZARDS THAT STUDENTS HAVE TO FACE. THE SKILLFUL TEACHER WILL HAVE MANY OFFERINGS IN HIS REPERTOIRE".

Need for an instructional system - the criteria of a good technique of teaching - the difference between teaching and transmission of information - the traditional verses modern concept of teaching - learning process.

Approaches in instructional techniques - developmental versus authoritative - inductive and deductive - the art of questioning -

The importance of planning for instruction - objectives - Expected behavioral outcomes - learning experiences - variety, intensity, appropriateness, quality - testing and evaluation.

The different methods of science instruction - course based versus competence based course of instruction - Lecture,- Demonstration - steps and rules - Discussion - problem solving - Heusistic - Project - steps - Histarical - The Physics Project Laboratories. The Keller plan - Lab - centred [illegible] mode - MODULE -

.....

POST -
ORGANISER

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PROJECT WORK

It is said that "Practice makes a man perfect". The aim of Project work is to make an Engineer perfect. Another profession which is some-what close to the Engineering Profession is the medical profession. Let us think of a situation wherein the medical students are taught everything about human physiology, nature and cause of diseases and details of medicines for various diseases, but are not exposed to the practical work of examining patients. If such graduates with very good theoretical background but almost no practical experience are produced by medical Colleges, they will either cut a sorry figure before the patients or make others feel really sorry for their patients. Luckily, such a situation does not exist in the medical field. Most of the teachers of medical colleges are practising doctors in hospitals. A medical College is always associated with a sufficiently big hospital. And one year of house - surgency is a prerequisite for all medical graduates. So medical education encompasses good amount of theoretical knowledge and necessary practical training.

Engineering profession is some-what similar to Medical Profession. A doctor deals with a living system whereas an Engineer deals with a Physical system. A doctor is entrusted with the task of keeping the human systems in good condition but are not responsible for the design of such systems. But on the contrary, engineers are not only responsible for the welfare of the Physical systems but also their design. But, Engineers, especially in India, learn lot of theory regarding physical systems, but very little regarding practical aspects. The laboratory work they do is just a verification of what they have studied in theory and is somewhat limited in its scope. The laboratory work is just a proo for the theory. What we expect from Project Work is to build something using theory

of convicted persons whom the court pronounced as guilty and were expecting death penalty by hanging or otherwise. Even in such cases, if the conviet does not agree, such experiments cannot be conducted. On particular convict agreed to become the subject for such an experiment and the court also granted permission. The conviet was shifted from a jail to a hospital. The scientists told the convict that they would slowly and steadily drain blook from his body and during the process the conviet was expected to tell the doctors how he felt. The convict was made to lie on a bed and arrangements were made to drow blood slowly and steadily. The experiment was started. After draining 1% of blood from his body, the doctors said that they drained only 1% and low the patient felt. The patient said that he did not feel any difference. After draining 10% they asked how he felt. The convict said that he could feel the difference now. When the doctor said that 20% of the blood had been drained, the co vict said he started feeling week. They increased the draining process. It was 30%, 40% and then 50%. When the doctor said it was 50%, the convict said he was very week. When the doct said 75%, the convict closed his eyes and breathed his last. Does this mean that a person dies if 75% of the blood is drained off? No. The truth is that the doctors had not drained even one milli litre of blood. But they made the convict believe that the blood was being removed. As the doctor was announcing the percentage of blood being drained, the mental state was changing and this was effecting the body. When the doctor announced 75%, the mind accepted it and thought that it was impossible to live if 75% of blood is drained off and hence he died. By this expe-riment they scientists wanted to show the effect of mind on body. The state of the mind not only effects the body but also the intellectual ability and performance. The aim of project work is to make Engineers to hav a mental state which

PROJECT WORK

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The challenge the engineers have to face is more Onerous than that of doctors from the systems point of view. The human system does not seem to have changed since several thousand years. Doctors have been studying and working on the same good old model. But the task of Engineers is not so simple. The systems on which they operate themselves gradually change. When an engineer deeply studies a systems and conclude that he has completely understood its intricacies, he finds to his dismay that the system itself has become out-dated gone out of market. This is clear if we study about 50 years of the history of computers. The earliest mechanical computers used Mechanical gears. Then came electrical computers using Vacuum tubes. They were replaced by semiconductor devices. They in turn were replaced by SSI I.C. Chips. They were again replaced by LSI I.C. chips. So if the Computer engineer wants to remain will-informed he has to study the new systems. The doctors may not have the necessity of studying new types of human systems unless different types of humans with new types of body structure come to live on earth from a distant planet.

In this connection I am reminded of a small story. It seems once there lived a doctor who was very famous. He was having very good practice and he used to change quitte heavily. Once his imported car went out of order. He took it to a garage which belonged to one of his former patients. In the garage the repair work was attended to. The next day the doctor received the bill. When he sow the amount in the bill jumped fran his chair.

"What do you mean by charging so heavily?" the Doctor shouted at the garate - owner.

The garage - owner replied, "I have to change like that Doctor. Think how you changed when I was dischanged from your nursing home last month. You have the advantage of working on the same model. But we cannot afford to do so. The models of cars change every now and then".

BUILDING CONFIDENCE:

The physical systems on which the Engineers Work are so varied in nature that it is difficult to make Engineers proficient in all types of practical work. It is humanly impossible to give all types of practical knowledge to Engineers. And it is not necessary also. And there is one thing which is common for all works. This common denominator is what is called as "Confidence", If an Engineer has a good theoretical background and confidence of doing practical work, he can shoulder responsibility in any field. The aim of project work is to instial confidence in Engineers. Confidence is a result of a particular state of the mind. Mind is mainly responsible for the success or failure of an Engineer or any individual. If the mind makes a person think that he can accomplish a certain thing, he can difinitely accomplish it. If the mind makes him to think that he does not have enough resources to achieve it, purhaps he will be failing in his task. I would like to drow your attention to the importance of the state of the mind by narrating a psychological experiment.

This particular experiment was conducted in a western country. It was a psychological and a physiological experiment. The scientists involved wanted to study the effect of mind on body. First of all they wanted to know how much blook they can drain from a body before the soul leaves the body. But how to test it using humans? Who will be prepared to become subjects for such fatal experiments? The scientists throught

of convicted persons whom the court pronounced as guilty and were expecting death penalty by hanging or otherwise. Even in such cases, if the conviet does not agree, such experiments cannot be conducted. On particular convict agreed to become the subject for such an experiment and the court also granted permission. The conviet was shifted from a jail to a hospital. The scientists told the convict that they would slowly and steadily drain blook from his body and during the process the conviet was expected to tell the doctors how he felt. The convict was made to lie on a bed and arrangements were made to drow blood slowly and steadily. The experiment was started. After draining 1% of blood from his body, the doctors said that they drained only 1% and low the patient felt. The patient said that he did not feel any difference. After draining 10% they asked how he felt. The convict said that he could feel the difference now. When the doctor said that 20% of the blood had been drained, the co vict said he started feeling week. They increased the draining process. It was 30%, 40% and then 50%. When the doctor said it was 50%, the convict said he was very week. When the doct said 75%, the convict closed his eyes and breathed his last. Does this mean that a person dies if 75% of the blood is drained off? No. The truth is that the doctors had not drained even one milli litre of blood. But they made the convict believe that the blood was being removed. As the doctor was announcing the percentage of blood being drained, the mental state was changing and this was effecting the body. When the doctor announced 75%, the mind accepted it and thought that it was impossible to live if 75% of blood is drained off and hence he died. By this expe-riment they scientists wanted to show the effect of mind on body. The state of the mind not only effects the body but also the intellectual ability and performance. The aim of project work is to make Engineers to hav a mental state which

instils confidence in them so that they can shoulder any type of responsibility.

Types of Project Work:

They can be broadly divided into 4 types.

(1) Purely theoretical work

(2) Purely hardwave - oriented work

(3) Simulation work using computers.

(4) Survey type of projects.

It is not possible to say which is better and which is worse. Each has its plus and minus points. The students must be made to make their own decisions. They are expected to very good work in the area in which they are very much interested. Interest and accomplishment are very much related.

You must have heard the story of a Duke's son. It seems in England there was a very rich Duke who wanted his son to enter combridge. But every time in the entrance examination the Duke's son failed in Latin language. When the boy failed three or four times like this the Duke was Worried. Finally he engaged a young tutor to give the boy tuition in Latin. The tutor gave him tuition just for a month. This time the boy seored very high marks in Latin. The Duke was very happy and asked the tutor as to the sceret of his effective teaching. The tutor said: "The sceret is this Sir. Interest is strongly coupled to accomplishment. I have a collection of very interesting sex books and other pornographic literature written in Latin. I used to give only one book at a time to your son and used to ask him to return it the next day. The boy found the book so interesting that he used to read it again and again many times before returning it to me the next day. Like this I made him to read about 30 sex books written in Latin. As the subject was very interesting to him

he studied all the books with interest and hence attained proficiency in Latin". Of course, it is not in records as to what the Duke replied. I have cited this example to underscore the point that interest and accomplishment are closly related. So it is essential that the students should be given a free hand to make their own selection of project areas according to their interest.

Purely Theoretical Projects:

Such projects consist of theorems, Lemmas, proofs of theorems, speculations, suggestions, and so on. They are devoid of practical aspects and possibilities. When I was in Indian Institute of Science, a few years back, I know a research scolar in the Electronics and Communications Department. His terms and conditions for doing research work were somewhat very strange. He used to say. I do not want to touch even one transistor, resistor, capacitor or an IC chip during my research work. I do not want to enter the computer centre for feeding a program. My requirements are : very minimum. I want some white paper and a pen. That is all." He was very firm in his conviction. He nearly spent an year and a half choose a problem of his liking and to get a guide who would be willing to guide him. His terms and conditions appear very odd. But believe me, he did very good theoretical work and his work in his area was internationally recognised.

Purely hardware oriented work:

Such a project work consists of using Machines, materials and components. Some are really proficient in such works. It is an accepted fact that people who have a taste for theoretical work do not like practical work or are not proficient in it. Similarly people who are very proficient in practical work

You must have heard of the Austrian Physiciet, Wolfgang Panli, who is wellknown for his Panli's exclusion principle. According to Nobel Lauret Max Barn, who was one time teacher of Panli, if you consider scientific insight as a measure, then Panli might even overtake Albert Einstein. No doubt, Panli was a renouured theretical physicist. But he was a comolete failure in practical oriented work. He could never handle even a simple equipment. Peoole used to make fun of him saying that if he enters a laboratory even the most dependable equipment breaks down. His colleagus and students used to call it as Panli effect. Even Panli accepted his weakness in practical field and jokingly used to say that he would be remembered for Panli Effect rather than for Panli's Exclusion principle.

Once, in the James Frank Institute in Gatengen in Germany, a very costly equipment, all of a sudden, for no reason, exploded. No. one knew how it happened. Three days after this accident panli came to Gatengen. Narrating this, James Franle said," Mr. Panli, I am sure that you are not responsible for this since you are coming here only to-day and the accident occured three days back. " Panli thought for a while and said: "Wait a minute. On the day of the explasion of the equipment, I was travelling from Zuric to Copenhagen. The train passed through Gatengen. At the time when the explosion occured, the train was in the Gatengen station. Moreover the railway station is just behing your Laboratory. I was actually in that train. So it is difficult to say that I am totally innoent." I have narrated this to bring home the point that those who have no taste for practical work need not take up such works, but concntrate on other types of works.

Simulation work using computers:

This consists of making a mathematical model of the problem and develop a algorithm to solve the problem. The suceess of the project depends on how good a person is in writing a program and how much of computer time is available. It is send that writing a computer program is more an art them a seiences. Moreover a carelessly written program may even make a fast computer to appeon very slow.

Survey type of project:

It may consist of two types

(1) It may be a survey of work done earlier. The work consists of reading, glaning and compiling.

(2) The work may be a survey of the existing plants and systems. The success depends on the cooproation of others.

Recently our students undertook a survey of electronic equipments in hospitals.

Financial Resources:

Last but not the least aspects of project work are Financial resources. Money is not every thing. But every thing needs money. The only type of project which does not need any money is the purdy theoretical project. The hardwave oriented projects require money for purchasing compoonents and materials. Computer oriented projects are also expensive as payment is to be made for using the computer time which is about Rs.600 per hour. Survey type of projects also require money if students are to visit no of places.

What is the source for money? The amount sanctioned by the University of Directorate for project works is very meagre. In some Colleges the management meets these expenses.

Some times private Industries come forward to Finance eartain projects if they feel that the project is useful to them. In Karnataka State we have the Karnataka State Council for Science and Technology known in short as KSCST. The KSCST funds some projects if the projects are rural oriented. The rural orientation tag is very essential to expect financial aid from them. For that matter, satisfying any committee is a very diffcult task. Even a famous scientist of the staure of Newton had to struggle hard to convince a committee while pushing a proposal.

Who has not heard of Newton and the Apple falling from the tree? But many may not be knowing as to what happened subsequently. On seeing an apple falling from a tree on to the ground, the idea of gravitational force entered Newton's mind. He applied to the queen for sanctioning a grant for pursuing research in this area. In a reply the queen asked Newton to present his proposal before a committee set up for this purpose. On a fine day the committee met and Newton presented his proposal. In a few sentences he explained to them how the idea of gravitational force occured to him on seeing an apple falling from a tree on to the ground. One member asked him "well Mr.Newton, do you think there is any relation between the velocity of an apple and its sweetness. Another member asked whether Newton had any plans for improving the quality of apples grown in Ingland. Newton said that his research work was not in any way connected with the quality of apples. In fact, apples do not have any importance in his proposed research work. Then the third member said that it was very essential to improve the quality of apples rather then doing research work on some abstract and useless subject. There or four members stouted talling simetaneously. So Newton was forced to became a silent spectator. The meeting was finally adjourned for the next day. Next day Newton was late to the meeting.

When he went there, the committee had stouted the deliberations. Newton gently knocked at th. door. The gate-keeper opened the door, stoned at Newton for a while and said" I am sorry Sir. All the seats one full". Newton went back thinking that the committee had no intensions of seeing him. So his lost all hopes of getting any grant for his prooosed work.

After several months, one day Newton received a think cover. There were some 25 forms inside the envlope. The committee had granted some mony for Newton for doing research on varicties of apples, their quality and sweetness, and their velosity of falling and their inter-relationships. It was also written that the main aim of the project was to improve the quality of apples and see that they fall gently from the tree on the ground so that they were not spoiled. Newton was suppored to fill up the forms and send his acceptance. Newton sank in his chair.

- - Dr. K. Chidananda Gowda
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PROBLEMS OF ENGINEERING TEACHERS

Let me try to present these immediate problems in College teaching which point directly to need for changes in those determining values which control the preparation for membership in the fraternity of college teachers.

The first of these problems is the total lack of defined responsibility for recruitment of students. Teachers are forced to teach the students who are admitted and who do not have an aptitude for learning. So I appeal, to the dominent motivations of a great profession rich in compensations of the spirit. Unless there is a response of genuine integrity to this appeal, the renewing vitality which sustains that profession may flow too freely into industry and market place.

We are forced to rely on an unorganised but sincere approach to promising students by those who find ample satisfaction in their way of life. Unless we recognise our personal responsibility for recruitment, college teaching will continue to be for many not a prefered profession but a residual calling. This is our first problem.

Our second problem stems from the obvious lack of relationship between the curriculam and the expressed purpose of the College. We seek, often in vain, for an intelectual design in the curriculam. Subject matter is developed in unrelated little packets which have meaning for specialist, but leaves the students cold. Units of subject matter are divided and subdivided untill the third dimension is compleatly lost. There is a disturbing discreatness about the elements of curriculam.

Our third problem has its roots in the aimlessness of the process of instruction. Allmost all our courses are taught by lectures, who are taught by text books. We are

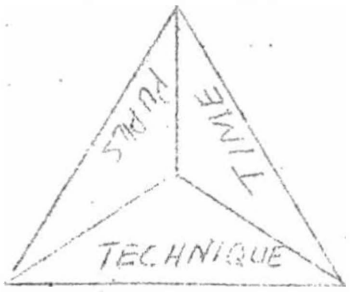
If one imagines the classroom situations the teacher exhibits/uses one of the skills at a time but the teaching as a whole is a combination of various skills in varying degrees.

The development of these skills in the teacher is obviously a step in developing a competent teacher. If these teaching skills are developed in isolation and then they are combined the effect is better than when all are practiced simultaneously at the initial stage.

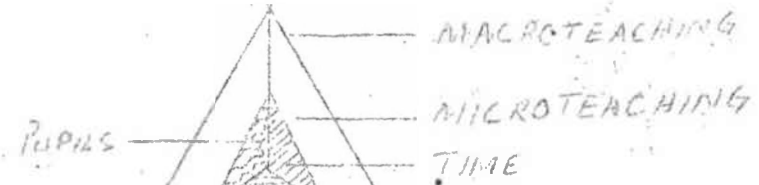
Generally full fledged teaching is planned keeping following factors in mind.

1. Time
2. Technique
3. Size of the class

This can be diagramatically represented as follows:



Here the technique involves various skills. The process of practising various skills in isolation may be termed as microteaching. Microteaching is scaled-down teaching with respect to time, size of the class and number of skills practised. In general, micro-teaching sessions are of 10 minutes, with 5 to 10 students. These students may be real students or peer group posing as students. The relationship of microteaching with macroteaching can be represented as follows:



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becoming just notes producing machines than lectures. This is because there is no wayout for-us to read about the latest developments, and convey them to students and thus create interest and to make our exposition clear and effective.

The fourth problem to which we address ourselves grows out of the question of the supervision of class activities. The novice in every profession is assured of well intentioned if not helpful supervision and guidence by experienced couleges. But in College teaching we find an impressive exception. The young University Graduate is entrusted with the teaching of college classes, often with no more assistence than is afforded by a syllabus of the course he is to teach. So proper guidence must be given by experienced to the novice, as in other professions.

We have examined only four major problems in College teaching; lack of responsiblity for discriminating recruitment; an over weighted curriculam that lacks intelectual design; teaching practices that are not shaped by identifiable purpose; and the absence of constuctive supervisions of classrooms and lecture hall practice.

We shall not here discuss the problems that stem from overlarge enrolement that tax the facilities of the College; nor from the inadequate preparation of those students whose admission is determined by considerations only remotly related to the primary purpose of the College; nor from the irreparable loss of superior faculty members because of the successful competition set up by private industry and by government. Nor shall we discuss the problems that spring from anaemic budgets that have long been stretched beyond the point of maximum elasticity. The solution of these problems is probably beyond the scope of us, the Engineering College teachers.

Presented By:

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MICRO-TEACHING

Teaching is a ternary process; X teaches Y to Z. Here X is the domain of teach Y is that of the learning experiences and Z is the domain of learners. The techniques and methods adopted by the teacher play significant role in the effective communication in the classroom. Besides human learning largely depends upon attending to relevant sources of information. The learner perceives the situation and tries to select the relevant information. We cannot cope with all the informations inputs through the various senses most of the time; therefore, in order to understand the environment, one has to learn to focus one's attention on a few aspects of the practical field. It is the teacher's duty to help the pupils to focus their attention on the particular tasks in which they are engaged.

Ultimately it is teacher's composite behaviour which is most important in the effective communication. What constitute the desirable teacher's behaviour has a reference to a particular situation. But the teacher's classroom behaviour is the combinations of various skills. These skills may exist in varying degrees in the composite teacher behaviour. For different situations in the class different set of skills are required.

In developing the competency in the teacher, the identifications of these skills is the first job. The following are the listing of few of them.

1. Stimulus variation
2. Reinforcement
3. Probing questions
4. Illustrations and use of examples
5. Set inductions (skill in focusing the attention of a class on a goal/problem)
6. Explaining
7. Asking divergent questions and
8. Closure (rounding off the lesson) etc.

If one imagines the classroom situations the teacher exhibits/uses one of the skills at a time but the teaching as a whole is a combination of various skills in varying degrees.

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Generally full fledged teaching is planned keeping following factors in mind.

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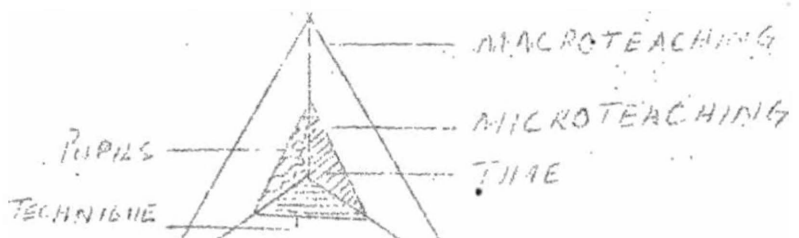
This can be diagramatically represented as follows:

Here the technique involves various skills. The process of practising various skills in isolation may be termed as microteaching. Microteaching is scaled-down teaching with respect to time, size of the class and number of skills practised. In general, micro-teaching sessions are of 10 minutes, with 5 to 10 students. These students may be real students or peer group posing as students. The relationship of microteaching with macroteaching can be represented as follows:



Here it is to be understood clearly that micro-teaching is not a teaching technique but it is a technique by which the teacher may prepare himself for an effective performance in the class. In teacher training colleges this technique is being used for teacher preparation.

Microteaching sessions

Microteaching operates as a system. The inputs of the system are written materials, describing the skills, the teacher (as a trainee), supervisor, peer group and students, and viedeo tape equipments, if used. The output is the teacher who can demonstrate and use specific teaching skills. The process goes through the following stages:

1. Planning	2. Teaching	3. Feedback
4. Replan	5. Reteach	6. Refeedback

The system works as follows: The teacher identifies a skill, plan a lesson and then teaches to a small group of students (say 5-10)for about 10 minutes. If real students are not available the peer group is made available to pretend as students. While teaching the emphasis is on the skill not on the subject matter. The lesson, which is meant to practice a skill, is supervised either by one person or peer group. After the lesson is over the teacher sits with supervisor(s)for feedback. On the basis of suggestions offered by supervisor(s) he replans the lesson. He reteaches and again goes with supervisor(s) for refeed back. If it is found that skill is not properly developed he goes through the sequence of re-replan, re-reteach and re-refeedback. This continues till the skill is developed sufficiently.

In engineering education a host of skills are required to perform a job effectively. These skills are to be analysed and praticed, initially in isolation and then coordination of various skills should be practiced, In particular, an engineering teacher does lecturing, demonstrations etc. Certain important points are to be emphasised during each process. Besides various other skills variation is also desired to break the monotony in the class and also to emphasise at plug points to made the concept clear. In the following section the skill of stimulus variation is detailed out.

Skill of variation

Rationale

As has already been mentioned in the preceding paragraphs, that one cannot cope with all the information inputs through the various senses; most of the time, therefore, one has to learn to focus one's attention on a few conceptsof the perceptual field.

Psychological researches have shown that attention tends to shift from one stimulus to other very quickly. It is very difficult for one to attend to the same stimulus for more than few minutes and in some cases few seconds or even less. Therefore by providing changing levels of sensory input attention will be maintained and this attention is a necessary prerequisite for learning to occur.

There are a number of factors in the external environment of the individual which influence his learning. Following is a mention of a few of them.

(i)Intensity: The louder a sound, or the brighter a light, the more it tends to capture one's attention. However, except where the loudness or lightness are so great as to cause discomfort, one's perception quickly adapts to different intensities, so that a continuous loud sound or successive brightly

coloured pictures tend to have a quickly decreasing effect in attracting attention.

(ii)Contrast: Anything which is bigger than the things which surround it, or in any other way different tends to catch attention. This applies both to the things in one's perceptual field at any moment and also to differences occuring with time. The clock which stops tick ing is noticed more than one which goes on **ticking**..

(iii)Movement: Our eyes are attracted to anything which moves or which moves in a different way from the things which surround it.

(iv)Self-Activity: We usually attend more to things which we ourselves are doing, for example to objects we are manipulating, than to things over which we have no control.

Behavioural Definitions of the skill

The skill of variations implies attracting and focusing pupils attention by changing stimuli in the environment for securing and sustaining pupils' attention leading to greater pupil interest and achievement. It has the following behavioural components.

Teacher movement:Purposeful movement from one place to another e.g. moving to blackboard, moving to look at children's work, moving forward to pupils. (Exclude aimless wandering or pacing up and down; such habitual movements can be distracting or can be as monotonous as lack of variation.)

Teacher Gesture: Movements of parts of the body to direct attention, to emphasize importance, to express emotions, or to indicate shapes, sizes, movements etc.

Change in

Speech Pattern: Sudden or radical changes in tone, volume

strong emphasis on particular words or phrases). Be strict - exclude these incidents where doubt occurs.

Change of

Sensory Focus: Changes in the sense-channels which pupils are asked to use, e.g., listening to looking, discussion to manual activity, reading to writing; also, major changes of focus within one sense-channel, e.g., from blackboard to film, from teacher talking to audiotape, from writing to building models.

Pupil Talk: (Verbal Pupil Participation)

Pupil speech or verbal pupil participation asked for or intended by the teacher (though one should probably exclude one-word answers which punctuate a teacher monologue).

Pupil Movement: (Physical Pupil Participation)

Pupil movements or physical pupil participation asked for or intended by the teacher, e.g., handling apparatus, dramatization. As can be seen from the verbal descriptions, these behavioural indicators of variation cannot be identified absolutely unambiguously by any one observer. For example, to assert that Teacher Movement has occurred one has to infer that the movement was purposive. However, there are also some unambiguous examples of these indicators which are usually fairly simple to spot.

The systematic observation of teaching behaviour is difficult, especially when that teacher behaviour is your own, and when a quickly moving lesson is taking place. Therefore, the system we have adopted is to break the lesson into 30 second intervals and to code the occurrence of the skill components according to whether or not they have appeared during any 30 second period. Below, for example is the record of a five-minute lesson in which much Variation appeared.

Variation Coding Form

Interval (30 Sec.each)	1	2	3	4	5	6	7	8	9	10
Teacher Movement										
Teacher Gesture										
Change in Speech Pattern										
Change of Sensory Focus										
Pupil Talk										
Pupil Movement										

MOHAMMAD MIYAN
Lecturer in Education
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A P P E N D I X

SPEECH FOR TEACHERS

By: Dr. RATHANA.

Speech speaks about you as of its content. The main purpose of speech and language in a class room are: Motivation, Attention, Communication.

Let your voice be optimum in frequency and intensity.

Project it: Speech must first be pleasant and audible.

Projection is optimum voice articulated properly.

Articulate properly (Open your mouth)
(Be precise)
(Use a little prolongation)

Proper projection should be appropriate for the size of the audience.

Incorporate properrhythm and intonation. Provide variation. Monotomy induces sleep. Speech is not loud reading.

Use language - words and sentences - appropriate to your audience. Provide for adquate redundancy. Remember the purpose of teaching is not to exhibit yourself but to express yourself. You have a message to convey. Go down to their level and slowly guide them up to your level. If you know your subject well, as you doubtless do, you will have not trouble explaining it at any level in any language.

Watch for these symptoms:

hoarseness
fall in loudness
fatigue after a couple of classes
pitch breaks.

If any of these arise, you are not using your voice well,

CURRICULUM PLANNING, MONITORING AND EVALUATION*

Dr Malathi Somaiah

The system of technical education in this country was designed on the model of western countries. The curricula included four main elements viz. basic science, engineering science, applied technique and design and liberal studies with specific purpose to serve the engineer as a solid foundation for continuous growth throughout his professional life. Especially the engineering curriculum has not undergone major changes in the last few decades to meet the emerging social and economic needs of the country. The kind of courses offered in these colleges and their relationship to the job needs have not been highly relevant.

There are a few institutions in the country like the Indian Institutes of Technology and some engineering colleges who have research centres attached to these institutions and they conduct periodical surveys and some attempts are made here and there to add or delete a few courses in the engineering curriculum. More than this there has not been any attempt made on a largescale, on a scientific and organised basis to evaluate and change the curriculum. This is also because most of the faculty teaching in these institutes do confine their activities only to teaching the academic subjects prescribed by the department under the 'uniform syllabus'. They neither have the time nor the interest to look into questions such as what is curriculum? How it should be developed, implemented and evaluated? One of the reasons for this kind of an attitude on the part of the faculty could be the lack of training and expertise on their part to play any role in the curriculum development of the colleges in which they teach.

In this paper the concept of curriculum, the dimensions of its planning, the foundations on which it is modelled and the problems and challenges before the colleges for monitoring and evaluating curriculum have been highlighted.

Curriculum is defined as the total effort of a school/college to bring about desired outcomes in the school or out of school situations. It is also defined as a sequence of potential experiences set up in a college for the purpose of disciplining the youth in group ways of thinking and acting. Curriculum is also

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*Paper presented at the "Summer School on Methodology of Teaching and Training" Organised by SJ College of Engineering, Mysore - From 4 Aug 80 to 31 Aug 80.

viewed as a process in which it is seen as a way of preparing young people to participate as productive members of our culture. It is also looked at with the emphasis on the learner since it is a plan for learning. Knowledge of the learner and the learning process has bearing on the shaping of the curriculum. These definitions suggest that various disciplines and theories have contributed to curriculum development.

Foundations of curriculum development are routed in five broad areas of study.

(1) History of Education provides a backdrop of past developments in the field of engineering education.

(2) Philosophy of education emphasises the points of view and systematic procedures for use in clarifying issues and problems and making decisions at many points in curriculum planning. The questions such as what is knowledge, truth, the concept of a teacher etc. get clarified by the philosophical foundations.

(3) The social foundations provide information on societal values, change problems and conditions that are requisite in program planning.

(4) The psychological foundations suggest the guidelines in relation to individual growth, development and learning. Especially, in a learner-centred curriculum, the theories of learning, the characteristics of a learner form the core of the curriculum development.

(5) The disciplinary foundations provide data, concepts, and generalisations along with modes, techniques and processes of enquiry for use in areas of curriculum.

An understanding of the foundations of curriculum is helpful in several ways.

(1) It helps in planning curriculum and instruction as the program is attuned to philosophical viewpoints, psychological principles, social requisites and material drawn from the disciplines.

(2) It helps teachers understand how various forces and factors touch the lives of students and parents. It is also possible to provide better guidance, improvement in interpretation and acctuability to parents, public and other college personnel.

(3) It helps teachers and other academic personnel to put problems and issues in perspective and devise changes and improvements that are consistent with basic values and other factors as illuminated by various foundations.

(4) Direct contributions are made to one's working philosophy of education. It has innumerable practical and theoretical applications in curriculum development.

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Three approaches are followed in clarifying the foundations of curriculum development.

(1) Direct use of studies and reports prepared by experts in various foundations or by specialists.

(2) Use of consultants to curriculum committees who indicate the ways of improving the programmes by considering the foundations.

(3) Issues and problems as they arise in the process of curriculum planning are used as the key points in going to the foundations to search for a base for decision making.

With these foundations for curriculum development, a curriculum covers four important elements.

(1) It covers either a statement or an assumption of the aims of one's schooling, of the kind of youngsters and the kind of adult one is trying to produce.

(2) It contains a statement of the contents of what the learners are to learn and experience, and of the amount of choice they will have within that content.

(3) It contains a statement of the method or methods that are most likely to achieve these aims. How specific this statement is will depend in large part upon the level of education and training of teachers concerned. With well educated and thoroughly trained teachers, the most broad and general suggestions as to methods may suffice, but with less intellectually sophisticated teachers its often necessary to be much more detailed and specific.

(4) The curriculum must contain a statement of how the work of the colleges is to be evaluated.

Inappropriate methods of examinations or instruction can ruin any curriculum. When the bulk of teachers have reached a professional level where they can maintain their own standards, external examinations cease to be of great significance. But when ill-educated teachers are struggling on only a page or two ahead of their pupils, examinations and a fixed syllabus may give them the support they really need.

'Curriculum Development' is therefore a pervasive activity which should be sensitive to time and place. The curriculum should be continually developing to keep it in harmony with changes in pupils, knowledge and society.

In a comparatively structured setting, teachers need to evaluate and adopt curriculum program and materials produced by regional and national curriculum development centres or commercial publishers and the curriculum guides developed at the state or district level.

The following sequence of procedures provide means for effective curriculum development.

(1) Assessment of conditions in foundations areas as a basis for generating goals.

(2) Formulation of broad goals and specific objectives.

(3) Planning and organisation of curriculum content, instructional strategies of media, adaptation of outside program and materials, provision for continuous evaluation of instructional outcomes.

(4) Implementation of curriculum designs, teacher preparation, utilisation of support services, of facilities and equipment, carrying out instructional strategies.

(5) Evaluation, feedback and modification of curriculum design.

Determining Goals

Shane (1971) suggested that this process involves the participation of experts from a variety of fields in the identification of future trends and developments in their respective fields and estimation of the probability of the occurence of each. Educators and experts assign positive and negative values to each trend or development according to their judgement of its estimated social consequences - the probability of occurence of a particular trend and the anticipated case or difficulty of promoting or impeding it through educational means are worked out as a weighted score to determine the priorities for educational efforts, how educational resources might be invested to support desirable trends, resist undesirable ones, and avoid wasting efforts on procedures, materials or programs that prepare engineers 'for a world that either will no longer exist or should no longer exist'. This leads to hypothetical exploration of possible curriculum designs relevant to the priorities established in the third stage. The purpose is not to anticipate future, but to participate in shaping it. The procedure also includes periodic assessments of the procedures used and of the coherency of efforts and results from one stage to another.

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A 'Curriculum Development' project usually follows a pattern.

(1) Survey of chosen curriculum area by a panel of teachers and others, drawing on all available sources, leading to the precise statement of objectives.

(2) Creation of draft materials appropriate to stated objectives.

(3) Briefing sessions and 'workshops' with volunteer teachers from a few colleges where materials are to be tried out.

(4) Trial in colleges.

(5) Modification of materials in the light of effectiveness (evaluation).

(6) Perhaps, a second, more extensive trial and further revision.

(7) Publication and diffusion of new materials together with intensive and widespread programmes of retraining.

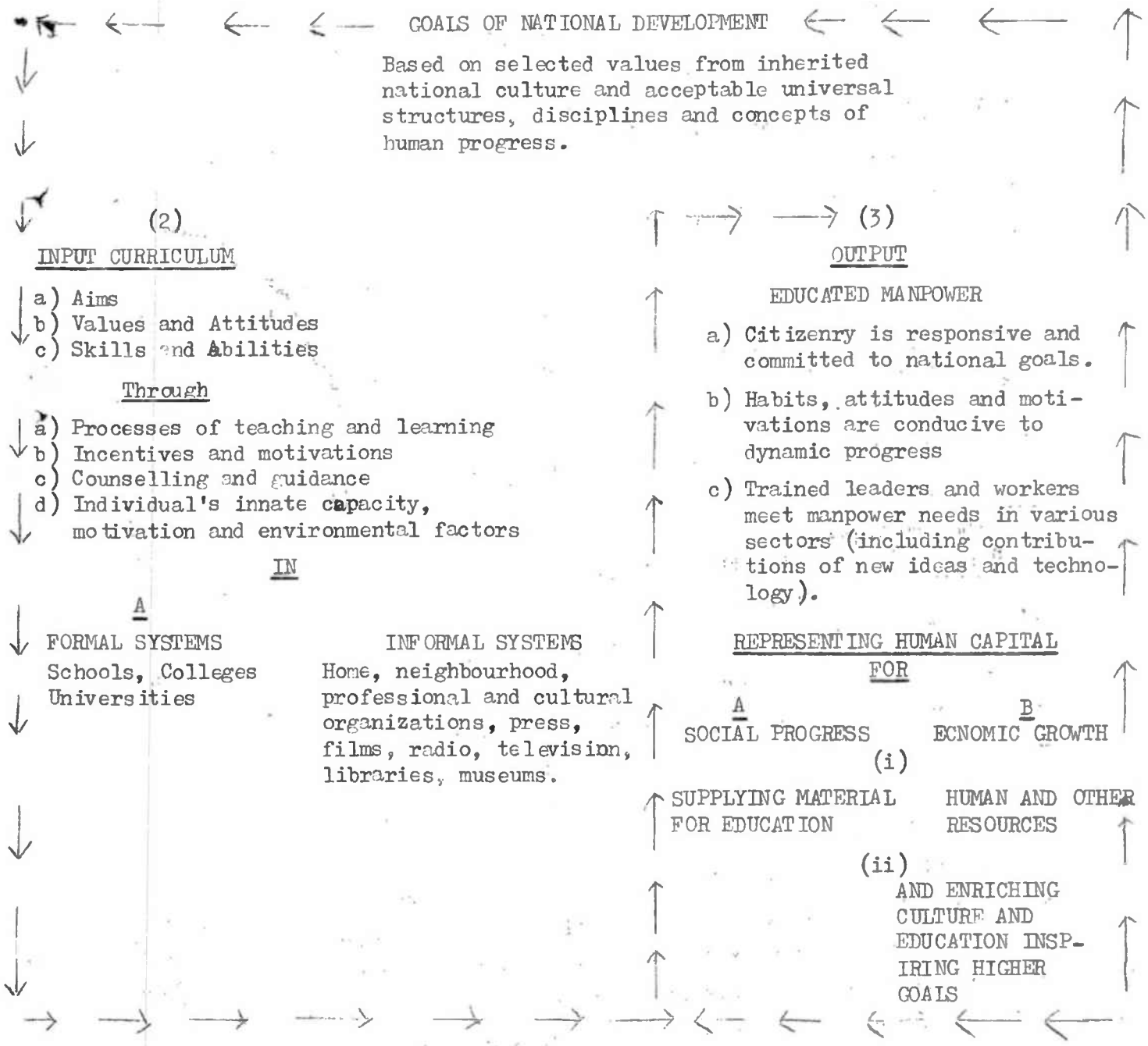
(8) Continuous evaluation and modification, as objectives change.

The crucial factor in this pattern is the need for a higher measure of teacher involvement and participation. Curriculum development cannot proceed unless the teachers are available and willing to participate.

The following model explains the processes of curriculum development and the coordination of the inputs required for designing curriculum.

Figure 1

Model for Curriculum Development[1]



Curriculum Planning

Curriculum planning should always take place at the classroom level both in the deliberate pre-planning of content and strategies for the year, a unit, a lesson, and in the daily, minute by minute decisions made in the process of teaching.

Learners are the curriculum makers since curriculum is ultimately determined by what the learner actually experiences and learns.

... 6

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... 7

Curriculum planning is, infact an unique process. Only those teaching within the institution concerned can be fully aware of the many local pressures that are being brought about in the working of the colleges. Although there is some insistence upon common elements in curriculum design and planning, no one can prescribe with minute detail the perfect solution for each and every college. Teachers are professional people, and as is said on several occasions, those who are responsible for the implementation of the curriculum should also be those who are responsible for planning it.

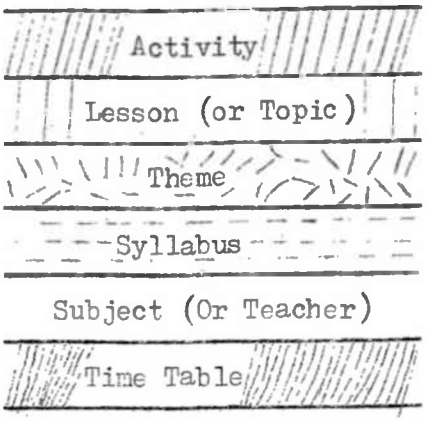
Curriculum has to be seen as a unity. Unless each section is related to each other section, and unless they are related back to and subsumed within some overall design, the achievements gained may very well be random, fragmentary and short-lived. The subject departments in a college may function superbly but will do so in a self-imposed isolation which gives impetus but hardly coherence to the whole.

An unified curriculum is important, but it cannot be divorced from those who teach it and those who learn through it. All too often work at a classroom level seems to bear no resemblance to curricular ideas spoken at professional meetings of the staff, nor does the curriculum seem to relate to life as it is lived outside the college.

One of the most damaging dichotomies of current education is this separation that exists between 'curriculum' and 'classroom', between 'schooling' and 'life'. It would be a sterile exercise to unify the curriculum of a school at a high level of abstraction without influencing the actual content of the work or the methods employed in the classroom. Similarly the curriculum must be a singularly negative and retrogressive element if it cannot be related directly to life as it is lived outside the school. If our curricula are to have any meaning at all these twin gulfs have to be bridged.

Figure 2

The Geology of Curriculum[3]



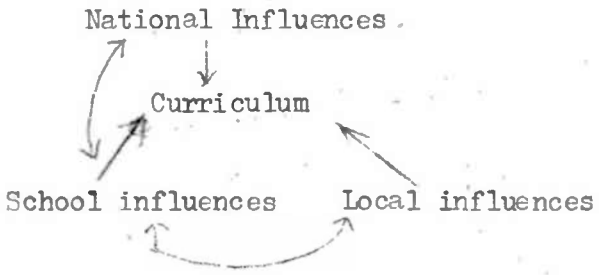
The activity may be part of a larger lesson or topic which forms a section of a 'theme' within a broader syllabus. The whole of this is put into a time-table in terms of the number of periods. Each of these layers relates back to that immediately below it and the strata are all interdependent. The curriculum has to be interpreted in the same direction by all teachers and its progress has to be discussed and monitored regularly at all levels and that it has to be recognised that for more than academic content of a syllabus is involved.

At national level, educationists have a rich variety of theories to expound on the very nature and purpose of schooling itself. Researchers come forward with multifarious ideas and sometimes conflicting findings. Politicians have radically different opinions regarding issues both large and small, these often being expressed with a vehemence in inverse proportion to their intrinsic worth. Economists come up with answers involving the gross national product, manpower utilisation and work potential. The main in the street, too has very definite ideas, probably culled down from distant memories of his own school days - some twenty years ago.

At a more local level, parents insist upon academic standards and an education which will improve the job prospects of their offspring.

Figure 3

Influences in Curriculum Design[4]



Sequence and balance are the two prime requisites of curriculum structure. Not only has a balance to be obtained between the different areas or domains, but also among the various approaches adopted within the classroom.

The 'Rules for Changing the Curriculum'

(1) Planning for change should take place well in advance.

(2) Curriculum change requires time for the ideas to the fully explored and for members of the planning group to begin functioning as an unified team.

(3) Organisation of change has to be simple - not in sophisticated forms.

(4) Those who implement it must participate in its planning.

(5) Curricular innovation should not take place in isolation - visits to other colleges are necessary.

(6) Nature of the changes should be made known to all related people and suggestions called for.

(7) Changes should be gradually introduced and monitored. Based on the results, it should be continued.

Actions that Facilitate Curriculum Improvement

(1) Create the climate and the working conditions in your institution to encourage curriculum improvement.

(2) Achieve and maintain appropriate tempo in curriculum improvement.

(3) Arrange for a variety of activities that leads to improvement.

(4) Build evaluation procedures into each curriculum improvement project.

Planning and Implementation : Challenges and Questions

Rapid social and technological changes, persistent social and political concerns and pressures and the multiplicity of the available curriculum alternatives, pose challenges and problems for the curriculum planners today.

... 10

These changes would provide a lot of parental and community involvement. It also offers professional freedom for teachers. In the administrative structure like our country, within the framework of a centrally specified structure for evaluation, a shift in emphasis can be achieved if cooperation between central authorities and colleges is sought in the conduct of the evaluation. At this point it is important to keep in mind that evaluation is a process in the total development of curriculum instead of being a product of curriculum development. It is also emphasised that participation of the teachers in the evaluation of curriculum is very significant especially in terms of their role as agents who would implement the needed changes in curriculum.

Responsibilities for curriculum evaluation could be shared in a cooperative approach involving the department, the college and the community in deciding on some aspects of an evaluation. Figure 5 indicates the broad categories of evaluation paradigms and likely roles within the categories. The alternatives are arranged from complete central control to complete college autonomy. The ticks (which indicate action) show the range from central initiative, through cooperative approaches, to evaluation that is internal and college-focussed.

The colleges should conclude a staff review of the college before an inspector or a supervisory staff visits the college for inspection. In these situations although colleges get an identifiable role in the evaluation, their departmental authorities who set the evaluation criteria are also involved in the evaluation itself. This retains an element of objectivity by preserving an insider/outsider distinction. The principal and staff of the college should evaluate all aspects of their college's curriculum in terms of the policies and objectives established at central level.

The cooperative development of an evaluation plan would ensure that it is mutually satisfactory and that the implementation by representatives of the department should assist in detaining an objective evaluation. The fact that the college had a say in the purpose and direction of the evaluation could help to ensure that the approach adopted was suitable.

The college should have a role in determining the focus of evaluation since the first phase of an internal review panel. This panel should consider only those matters of concern to college as addressed in the internal review. The central authorities influence should be more general in establishing the procedure of external reviews and in setting the composition, though not the membership of

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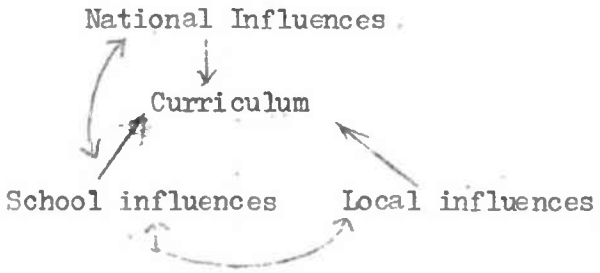

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Planning of curriculum should include administrators, curriculum supervisors, teachers, psychologists, scholars in education and academic disciplines and other resource people including community members - such as, people in business, industry, the staff of technological museums, libraries etc. Students, at the higher education level need to be included in the curriculum planning. Their participation may also be obtained through interviews, interest inventories, questionnaires or essays on preferences for types of learning activities, reactions to new materials or procedures, responses to the physical environment of the college etc.

The Multiple Role of Engineering Colleges Today

(1) The activities of the people of the college constitute the main areas of impact upon the region.

(2) The graduation of students influences not only the manpower needs of the state, but also the graduates own attitude and their socio-economic status.

Teaching programme in the engineering colleges have tended to change rather slowly. This leads to establishment of courses and curricula out of phase with the need.

There are various pressures which cause changes in curricula.

(1) Faculties own view of the knowledge that will equip a student in the best possible way for his future - in places where faculty have freedom to offer independent courses.

(2) Because of the changing requirements for post-graduate education.

(3) The individual student's development of the view of his interest - in places where courses are separately offered from various departments.

(4) The requirements of potential employers.

(5) The guidelines set down by the various accrediting bodies (recognising organisations).

(6) The standards set for entry into the professional courses by professional organisations.

(7) The engineers are trying to deal with the technological world - but not with the societal views.

Canjar, in a workshop, reports some of the significant factors in the role of engineering colleges to change the curriculum.

(1) Teaching, research and public service have to be interrelated.

(2) Engineering needs to be problem oriented and based on situations within a region.

(3) Engineering education cannot operate in public service in isolation from the rest of the universe.

(4) Each institution must design its own program or in relation with the region depending on its traditions, abilities and the nature of the region it serves.

(5) Effective public service should be the responsibility of the faculty and be recognised and rewarded.

(6) The department of the college must be planned with public service to the region in mind.

(7) Engineering curricula can influence and be influenced by effective public service.

Curriculum Evaluation

Curriculum needs to be evaluated at various points of time and for various purposes. It has been evaluated for its own strength, relevance and significance to the society that it serves. It is also evaluated periodically to ensure whether the processes have really achieved the stated objectives or not. The feedback from the evaluation are to be used for strenthening the curriculum of the colleges.

There are various models of curriculum evaluation which emphasise the participation of all related interest groups in modifying the curriculum. One such model is explained in the following pages which could be used with some modifications into the evaluation of the curriculum of engineering colleges.

Major policy decisions and curriculum matters are made by the central administration. In order to change this direction towards more and more of teacher participation, would need the following model.

Figure 4

Model for Curriculum Evaluation[5]

Broad Guidelines
(By Central Administration)

↓

Structure and Details of Curriculum
(College level)

↓

Required Facilities

↓

- Trained Staff
- Well qualified Curriculum Specialists
- Varied Textbooks
- Varied Instructional Aids

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These changes would provide a lot of parental and community involvement. It also offers professional freedom for teachers. In the administrative structure like our country, within the framework of a centrally specified structure for evaluation, a shift in emphasis can be achieved if cooperation between central authorities and colleges is sought in the conduct of the evaluation. At this point it is important to keep in mind that evaluation is a process in the total development of curriculum instead of being a product of curriculum development. It is also emphasised that participation of the teachers in the evaluation of curriculum is very significant especially in terms of their role as agents who would implement the needed changes in curriculum.

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Figure 5

Categories of Evaluation Paradigms[6]

		Initiated	Shaped	Information collected	Audience
CENTRAL SPECIFICATION					
Central Implementation	Central Admn.	✓	✓	✓	✓
	College Admn.				✓
Cooperative Implementation	Central Admn.	✓	✓	✓	✓
	College Admn.			✓	✓
College Implementation	Central Admn.	✓	✓		✓
	College Admn.			✓	✓
COOPERATIVE SPECIFICATION					
Central Implementation	Central Admn.	✓	✓	✓	✓
	College Admn.		✓		✓
Cooperative Implementation	Central Admn.	✓	✓	✓	✓
	College Admn.		✓	✓	✓
College Implementation	Central Admn.	✓	✓	✓	✓
	College Admn.		✓		✓
COLLEGE SPECIFICATION					
Cooperative Implementation	Central Admn.			✓	✓
	College Admn.	✓	✓	✓	✓
College Implementation	Central Admn.				
	College Admn.	✓	✓	✓	✓

the external review panels. These panels must include departmental inspectors and others from categories such as parents, community members, academics and staff from other colleges.

They decide the purposes and procedures of evaluation. Then, they gather the evaluation data. This permits the development of an approach that meets the needs of both parties. It is important that the evaluation approach remains flexible and non-institutionalised so that it can be decided cooperatively.

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In the third paradigm the responsibility rests entirely at the college level. Professional assistance can come from educational officers and inspectors with a name change to emphasise their role change. The department should encourage colleges to identify their areas of concern, control the processes of evaluation and control the way in which the results are used. The department's role should be to disseminate the evaluation information among colleges to provide personnel to assist colleges with evaluation program and to conduct in service courses on evaluation.

Existing Problems

Teachers regard evaluation personnel as another form of inspectors. Colleges are weary to report the results of evaluation for fear of comparison with other colleges. Teaching staff would report the evaluation process and not the evaluation results.

Conflict between the Policies for Curriculum Development and Curriculum Evaluation

When curriculum planning and evaluation are done by departmental officials there will be no conflict. When development is done without the evaluation, even then there is no conflict. When development and evaluation are left to the college, there is conflict. The responsibility to develop curriculum program should rest with the colleges. They should also be responsible for the evaluation of the policies related to engineering education.

The evaluation has two major functions to perform.

Aiding college development, assisting system accountability. When colleges can do self and voluntary evaluation, certain control mechanisms are essential to find out which colleges have gone to undesirable extremes and some mechanism for controlling such colleges are necessary.

Inconsistencies arise when : departmental administration develops curriculum policies and evaluation, provides freedom to colleges to develop their own curriculum and still expects them to stay near to their expectations. Curriculum evaluation is not mere evaluation of student performance - it is much beyond that.

Departments employ barely qualified teachers - aims, content, method are decided by the department to monitor whether change in the responsibility is essential. The departments give an appearance of freedom to colleges and responsibility to colleges But in reality they still control all aspects of curriculum development.

Suggested Pattern

(1) Departments should continue to monitor the functioning of colleges.

(2) It should continue to provide responsibility to colleges for preparing aims, policies and curriculum evaluation.

(3) An analysis of the purposes underlying the traditional procedures are necessary.

(4) The results of this policy should be announced as a policy which should be clear, consistent and practical.

(5) It is important to declare the aims and policies of the engineering education.

(6) There should be a specification of the relationship between aims and policies and the programs in the colleges.

(7) The colleges should have their judgement to decide on the method of implementing the central policy in view of the local circumstances.

(8) To develop a clear statement of the evaluation purposes and procedures, intended by department and expected by colleges.

(9) Colleges should be assisted to develop evaluation expertise. This requires support services and materials and extensive in service work-experiences.

The dissemination of curriculum information needs to be carefully planned. The results of evaluation should be used to reflect the purposes and procedures rather than a mere monitoring tool.

All these problems would be identified and dissolved if there was a clear statement of curriculum development and monitoring responsibilities.

Establishment of a body responsible for curriculum development known as Curriculum Development Center becomes essential. This will determine the curriculum to be followed or will produce ideas and materials which teachers are free to accept or reject at will.

Engineering colleges should take up socially relevant public service activities including consulting and community activities.

Research needs to be conducted on questions such as who enters an engineering college? What happens to them in an engineering college? Who graduates? Where would they be employed? Etc.

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Teachers' Centres need to be set up to provide facilities where teachers can meet, exchange ideas, examine and evaluate new programs and materials, engage in workshops, or participate in professional activities. Such centres would also serve as locales for joint curriculum planning efforts as well as resource centres for professional publications and curricular materials available to individual teachers. These centres could also conduct organised programs of further education of engineers and technicians after they join their profession.

In order to introduce all these changes in the present structure and system certain changes at the leadership level of curriculum planning and implementation becomes essential. Curriculam leaders should decentralise leadership and respect individual differences among staff members. Their role should be as consultants and guides rather than directors. They should also prepare and train other curriculum leaders. They should ensure that curriculum is continuously evaluated and changes incorporated. They must see that the techniques of evaluation are consistent with the principles for curriculum development. Sufficient attention should be paid for the practical testing of ideas on a limited basis and the dissemination of results. They must ensure the systematic gathering and appraisal of evidence which will serve as a basis for curriculum improvement. The engineering colleges should ensure that sufficient guidance is established regarding the effectiveness of curriculum planning in changing the quality of instruction. Objectives of both longterm and shortterm programs should be specified in terms of:

(a) changes sought in the educational program, and
(b) changes sought in staff perception and operation

The engineering colleges of today need to put a strong accent on management and economics in their curriculum. They also need to obtain an understanding of how industries work and all other areas which are mostly neglected in the usual engineering programs. They need to be quite sensitive to the changing demands and job market needs.

They have to recognise that inter-disciplinary areas with more emphasis on social values are likely to receive greater accent in the future. This kind of sensitiveness to the changing needs of the society and their role as trainers of the tecnnocrats of the country would bring them closer to the current realities.

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Footnotes

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6) Ibid, P.218.

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