PLANNING AND ORGANIZING PRACTICAL WORK

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1. INTRODUCTION

Practical Work is one of the vital components of any Engineering Curriculum. Its importance has, over the years, been realized by both the curriculum designer and the teachers. There has been an argument in favour of increasing the time allotted for practical work. The ratio of time allocated for theory and practical work has been debated as 40:60, 50:50, 60:40, etc. While adequate time is required for practical work, the extent to which the available time is utilized by the students is most important. Further, the quality of the practical work done by the students, the evaluation of skills acquired, and the opportunities provided to students for practice with motivational aspects integrated into the assignments are important. This paper includes suggestions prepared on the basis of long experience of the author.

2. IMPORTANCE OF PRACTICAL WORK IN PROFESSIONAL EDUCATION

Professional education needs to be learning through experience. Experiential learning is superior to learning by reading a book or listening to class-room lectures. Direct purposeful experience is superior to simulated experience. Simulated experience is superior to vicarious experience i.e. experiences provided by lecturing or by narrating. Technical and other professional education must therefore be made industry oriented and practice based.

In this article description of some innovative methods of providing experiential learning have been suggested. Specific suggestions have been made as to how to plan and organize practical work by the teachers, keeping in view the importance of practical work in professional education and training.

3. OBJECTIVES OF PRACTICAL WORK

One learns most when he performs. Performance could take many shapes. For example when we talk about testing a CRO, it is not writing a description of how to test a CRO. It is actually testing and certifying. An engineer has to transform his design into realities, A practical engineer is one who can make things happen. Practical work performed by an engineer will include installation, commissioning, testing, verifying, analyzing of test results, manipulating, modifying circuits and systems, observing, critical analysis, decision making, synthesizing alternative solutions, designing as per specifications, designing circuits and systems for customers needs, trouble shooting on existing system, maintaining, etc.

To develop these qualities and competencies in the students, the engineering curriculum provides for Laboratory work, Workshop practices, Field visits, Use of demonstrations, Industrial attachment, Project Work etc. In

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addition, while implementing the curriculum, the teachers plan additional activities which will provide for experiential learning with high transfer value. There are problems and constraints in the system. However, it is said that a successful teacher is one, who makes things happen, he does not wait for things to happen. The above is true for all types of professional education.

4. CORRELATING THEORY WITH PRACTICE

There has been a debate whether theory should be followed by practice or practice should be reinforced by study of related theory. Inspite of suggestions and appreciations of the idea that guided practice should be followed by study of related (need based) theory, most of the colleges are following the old established system of class-room based theoretical study first and then conduct of related practicals in the laboratories and workshops. While most of us are constrained to follow the existing system for the time being, there is need for correlation of theory with the practical work.

There are two implications of this requirement. First, the practical work must be relevant. Second, the time gap between the study of theory and conduct of practicals by a student must be reduced.

4.1 Creating relevance of Practical Work

An analysis of the list of experiments for a subject provided by the University shows that most of them are of verification type. When curriculum is revised, most often, the theory content is changed, the list practicals over the years remains more or less unchanged.

The practical work in the laboratory must create lot of motivation in the students. They must by aimed at developing real life skills. The need is therefore to revise the list of practical work as early as possible.

For the conduct of practicals, the students often come unprepared. They mostly depend on the teachers right from the selection of instruments to the analysis stage. For report writing, it is often observed that the students depend on old reports and follow a prescribed instructional sheet provided.

Practical work need to be geared towards the following :

(i) Inclusion of right type of experiments in the list,

(ii) Emphasis on development of skill like selection of instruments, design and preparation of circuitry or experimental set-up, recording of observations and their analysis, reporting, etc.,

(iii) Training in designing experiments by the students rather then providing prescriptions,

(iv) Use of computer simulations of experiments and guided question answer sessions for enrichment of understanding.

(v) Use of Computer in preparation of final report.

(vi) Working on mini projects on each subject area as part of practical work.

(vii) Use of video film presentations for covering study and demonstration type of experiments and for explanation of experiments provided by the teachers prior to experiments. (In fact lot of time can be saved if students are provided with CDs so as to view these experiments prior to their coming for practicals).

4.2 Reducing the gap between Theory and Practicals

The practical difficulty faced by the teachers has been to correlate theory with practicals. This is possible only when the multiple number of experimental set-ups are available. That is to say that for each experiment atleast five set-up

will be necessary (assuming that 4 students work in a group and 20 students come to practical class at a time). Universal type experimental set-ups and machines are now being made available where a large number of experiments can be performed using each set-up or machine. This allows performing the same experiment by all the student groups simultaneously and immediately after the study of theory. Some institutes are developing such experimental set-ups in-house as a part of student teacher project work.

In case these are not possible, an alternative is suggested below.

Teachers can develop laboratory manuals where each experiment is described briefly including explanation of the relevant theory as required for basic understanding of the experiment. These will be prepared as self learning material. Once the students know the experiment that they have to perform on a particular day, they can come prepared and by referring to the manual can perform experiment more or less independently and benefit from it.

5. USE OF GUIDED DISCOVERY TYPE EXPERIMENTATION

While in the theory class we often advocate shift from teacher centric teaching to student centric learning, the same is, in fact, more applicable in the conduct of practical classes. The students are to be made self reliant in their very approach to performing practicals. We have to move away from spoon feeding type exercises to more of exploratory type assignment oriented practical work. Such a paradigm shift in practical work is depicted in Figure I. (see on Page No. 44)

There may be different approaches to discovery type experimentation. One example of guided discovery type experimentation is provided below. For ease of understanding a very simple experiment has been chosen.

Name of the Experiment:

VERIFICATION OF OHM'S LAW

Objectives:

(i) To be able to set up an experimental circuit for establishing relationship between voltage and current in a simple electrical circuit

(ii) To write a statement of ohms law using the experimental observations

(iii) To identify circuits and conditions where ohm's law is not applicable.

Suggested Strategy

(i) Students are provided with the previously made observational details of voltage, V and current I in the circuit whose diagram is given.

(ii) Students are asked required to plot V versus I on a graph paper. They may be helped to find that the graph will be a *straight line passing through the origin.*

(iii) The students are asked to write the relationship between V and I (They may be reminded of the equation, $y = mx$, which is for a straight line passing through the origin)

(iv) The students are then asked to express in written words the relationship. The students are thus assisted in discovering ohms' law.

(v) Now, the students are required to perform the experiment independently.

(vi) Through questions and answers the students are guided to find out situations where ohm's law is not applicable. They may also find out applications of ohm's law.

The advantages of guided discovery approach is to gradually make students take initiative and

Teacher-Centric Practical Work		Student Centric Practical Work
• Fixed Laboratory set-up • Each experimental set up already decided. Do's and Dont's are strictly followed. • Students are dependent on instructions as to what to do, how to do. They come to conduct practicals unprepared. • Students depend on the teacher on deciding on the circuit diagram to be used, instruments to be connected, and so on • Same type of questions and answers are found in the report of each student	⇨	• Flexible Laboratory Set-up • Objective of the experiment are known to student in advance; • Use of guided discovery type experimentation; • The students are assisted in experimental set-up, selection of instruments, and preparation table of readings; • Students are assisted in analyzing the results and drawing conclusions • Teacher organises group interactions to enrich understanding Students are expected to take initiative in practical work

Figure 1. Paradigm shift in the strategy of Laboratory instruction

become somewhat independent in his practical work. This will develop confidence in designing new experiments winch is the requirement of life. They will also learn to reason out from their observations.

6. INTRODUCTION OF MINI PROJECTS AS PART OF PRACTICAL WORK IN EACH SUBJECT

A part of the time available for practical work can be utilized for doing some motivating type of project work by the students right from the first year of their study. The students will work for extra times in the institute and at home on the project. The students will get a feel of engineering from the beginning of their stu4y in the colleges. They will also learn to work in team, do market search, select components, fabricate, test, report, etc. Workshop facilities must be made available to students for this work. A project workshop could be established in the college which may be kept open beyond the teaching hours of the institute.

7. DESIGNING OF NEW EXPERIMENTS OR TESTING METHODS

At an advanced stage of students learning in the college, they may be trained in designing new experiments for a given purpose. This is a real life requirement. To increase the transfer value, the assignments should be real life like. The students may also be trained to test equipment as per specifications.

8. DESIGN OF WORKSHOP EXERCISES

Workshop exercises provide skill development opportunities. The following are suggested to make workshop classes more effective :

(i) More emphasis on perfection

(ii) Tidiness in circuit design and fabrication, machine operation, handling of tools and equipment.

(iii) Ample opportunities for practice

(iv) Use of real life like exercises

(v) Time tabling to provide enough time for completion of jobs.

(vi) Strict evaluation criteria for quality work output

Demonstration - Prompt - Release type of strategy may be used for conduct of workshop classes. Here the instructor will demonstrate to the students how a skilled job has to be done either as a whole or part by part; then the students will be assisted to do the tasks, and finally the students have to perform without any help to the mastery level of learning.

9. WORK-PLACE BASED PRACTICAL ASSIGNMENTS

Students may be assigned workplace based assignments as part of their study of subjects. Student groups will visit workplaces on off days and conduct market surveys. They are expected to observe, understand and prepare reports. For this, a type of check-list must be prepared by the teachers and given to student groups. For example, a group of students may be asked to visit an electrical substation and prepare a layout diagram and explain the function of each equipment and accessories installed including their broad specifications.

10. GUIDED FIELD VISITS

The institute has to view the whole of the environment as the place of acquiring experiences. The psychological boundary walls of the laboratories and workshops have to be broken and the teachers have to see beyond the four walls for giving learning experiences to students. Local fields visits must be planned and conducted. The learning outcomes have to be assessed. Disorganized visits yield very minimal of advantages. The field visit must be preceded by orientation lecture and followed by enrichment type group discussion.

11. PLACEMENT IN INDUSTRY FOR PRACTICAL WORK

Industrial attachment of students during each summer / winter break has to be planned. Industry, by definition, is a place where some economic activities take place. The teachers have to think laterally as to where to place the students for gainful experiences. For example, students of Mechanical Engineering could also be placed in Hotel industry to study quality control. Optimization, Customer satisfaction. Interactive skills. Communication and marketing strategies, etc.

12. USE OF DEMONSTRATION USING ICT

Information and Communication Technology (ICT) should by exploited to the full to provide learning experiences to students. Video Cassettes could be prepared to provide simulated experience to students of almost all engineering works. Bringing industrial processes and practicals in the class room using ICT will make engineering study more lively and realistic. Even demonstration of practical work will help students appreciate quality work.

The author has shown Video films of industrial wiring, house wiring, installation of motor control circuits, testing of machines and devices done by experts to students before they

actually did some of these in the workshop. The study showed lot of improvement in the quality of student work as also of their level of motivation.

13. EVALUATION OF PRACTICAL WORK

Immediate feedback is an essential requirement when students perform practical work. For any task, the component skills must be evaluated and feedback provided. The evaluation criteria must be made transparent to all concerned.

14. CONCLUSION

Practical work is more important than learning of theory. The attitude of everyone towords practical work must change.. It is not to be considered as a secondary activity. Some progressive institutes have integrated practical work and theory learning by removing the theory class-room altogether. It is the laboratories and workshops where all learning takes place. We have to constantly try to provide real engineering education to students and not merely theoretically oriented education

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