INSTRUCTIONAL DESIGN OF A REMOTE LAB SESSION

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Abstract

Practical work plays a fundamental role in training in electronic engineering. However, often the labs class are designed just to check the validity of a theory, the stages of discovery, exploration and creation are missing. This paper presents a methodology inspired from the Dick and Carey model, for designing a practical session that inculcates in students ability to acquire scientific inquiry skills, promoted by the organisation Accreditation Board for Engineering and Education. A design example demonstrates the implementation of the different phases of the “Biological Sciences Curriculum Study” (BSCS) 5E model.

Keywords: Inquiry learning, remote laboratory, instructional design, 5E Model.

1 INTRODUCTION

The practical work takes an important place in the teaching of the scientific and engineering disciplines. Traditionally, this teaching consists of an introduction of new concepts during a lecture, followed by a tutorial and a hands-on lab session. The lab session itself is organized in three phases:

a) Pre-lab session: the student performs a calculation or solves a problem to consolidate the acquisition of theoretical concepts.

b) Lab-session: The student follows an experimental protocol to perform measurements and collect data.

c) Post lab session: The student analyzes the data and compares the experimental results with the theoretical predictions.

This way of teaching allows the student to acquire many skills recommended by the Accreditation Board for Engineering and Technology (ABET) [1] and the European Network for Accreditation of Engineering Education ( ENAEE) [2] and compiled by Feisel and Rosa [3]. However, it does not prepare the student to think like a scientist. To achieve this latest goal, one must shift instruction from what student should know to how student should think. The pedagogical model advocated is that of experiential learning or inquiry learning [4,5] in order to enable the student to demonstrate his ability to design and conduct experimental investigations, interpret data and draw conclusions.

2 METHODOLOGY

Figure 1 summarizes the pedagogical design inspired by the Dick and Carey model [6].

a) Define what student should know or should be able to do before beginning this lesson.

b) Define what student should be able to do after completion of this lesson. Try to identify or link these skills to those identified by Feisel and Rosa [3].

c) Develop criteria for assessing acquired skills.
d) Develop the pedagogical strategy. In our case, we opt for the model of 5E recommended by the organization "Biological Sciences Curriculum Study" (BSCS) [7]. This method is illustrated in the case study.

e) Develop learning materials.

f) Carry out formative evaluation.

g) Carry out summative evaluation.

3 CASE STUDY

To illustrate the above, we apply the method to the design of a lab session in analog electronics dealing with passive filters. This session takes place at the beginning of training.

3.1 Entry Behavior

The session is intended for first-year students with very few theoretical notions. The only prerequisites are the practical skills acquired in a previous lab: the student must be able to use a function generator to generate a signal with a given characteristics and use an oscilloscope to measure the characteristics of a signal to be observed.

3.2 Phases des 5E

3.2.1 Engagement

The student has already studied the potentiometric divider in DC current shown in figure 2. The teacher asks whether the output voltage relation as a function of the input voltage remains valid in AC and whether the ratio depends on the frequency. The student performs the experiment and should conclude that the relation developed in DC remains valid in AC and that the gain does not depend on the frequency.

Figure 2. Potentiometric divider.

3.2.2 Exploration

The teacher asks what happens if the resistor R1 is replaced by a capacitor. The student makes measurements and concludes that the gain depends on the frequency. It will collect data for further analysis. The teacher directs the student on how to represent the data: plotted on a logarithmic diagram and introduces the concept of decibel and Bode diagram.

A variant consists in using the jigsaw classroom [8]: divide the promotion into groups A, B, C and D. Each group explores a variant circuit RC, CR, LR, or RL from figure 3. Students are led to characterize the nature of the circuit studied, which is a low pass or high pass filter.

Figure 3. Circuits to explore.
3.2.3 **Explication**

The teacher guides the student to the assumption that the impedance of the capacity depends on the frequency. The student recalculates the gain of the potentiometric divider with the new hypothesis and interprets the collected data. Then, the teacher introduces the cut-off frequency concept.

If the jigsaw method was used, the teacher forms 4 groups 1,2,3,4. Each group is composed of 4 students from A, B, C and D. The teacher invites the group members to explain to the other members the results of their observations. Thus a group 1 student who was in group C explains the results of the LR experiment that he has explored and receives from the other members of his group the results of the RC, CR and RL experiments that he did not perform. The students develop the skills of communication, argumentation and teamwork.

3.2.4 **Extrapolation**

The teacher invites students to explore circuits that are more complex in order to validate the theoretical model in Figure 4. We return to the classical process where the theoretical calculation precedes the experiment. The student must experimentally verify the soundness of the theory. It has a wide margin of manoeuvre. If the experiment is not in line with the expected results, he must learn from its mistakes. He has to repeat its theoretical calculation or its experimental process until the observation corresponds to the theoretical predictions.

![Complex circuits](image)

**Figure 4. Complex circuits.**

3.2.5 **Evaluation**

The teacher throughout the training process does the assessment. It is formative by providing feedback to students during the learning and summative process through a final examination that verifies to what extent the skills targeted have been met.

4 **CONCLUSION**

The traditional teaching of practical work allows students to acquire procedural skills, collect data and represent them. The proposed pedagogical method avoids hierarchical thinking. It gives the student the opportunity to demonstrate his ability to design and conduct experimental investigations, interpret data makes assumptions draw conclusions, communicate his results and work in a team.

This method cannot be realized in face-to-face teaching because it requires a great organization. The remote laboratory allows this because it is free of time constraints and allows multiple accesses to the laboratory. Further work will measure its effectiveness and its impact on students learning outcomes.

**REFERENCES**


