LEARNING IN THE LABORATORY: EXPERIENCES IN AN HYBRID BETWEEN THE EXPOSITORY AND THE INQUIRY LABORATORIES

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Abstract

There are distinct styles of laboratory instructions in chemistry education which can be applied to biology: expository, inquiry, discovery, and more recently, problem-based. This work is focused in a hybrid type between the expository and the inquiry laboratories.

The process consists of two phases:

- First, learners were trained in an expository laboratory. All the students at the first course participate in this training. Within this learning environment, the instructor defines the topic, relates it to previous work, and directs students' action.
- Later some students voluntarily participate in the inquiry laboratory. Inquiry-based activities are inductive. They have an undetermined outcome and require the learners to generate their own procedures. They are more student-centred, contain less direction, and give the student more responsibility for determining procedural options than the traditional format.

The aims (as general statements of what the teacher intends to achieve), and the objectives (as specific statements of what the students should be able to accomplish as a result of being taught in the laboratory) of this "hybrid" laboratory were analyzed and discussed.

Keywords: Laboratory instructions, Biology, Expository laboratory, Inquiry laboratory.

1 INTRODUCTION

Training in biology requires the student to come in direct contact with the scientific method. The knowledge from experimentation allows the students to understand the theoretical foundations through direct contact with the practical demonstration. In addition, the laboratory work increases disquisition capacity, teamwork and creativity of students. In addition, the laboratory work capacity increases disquisition, teamwork and creativity of students. Theoretical knowledge is thus enriched and completed by practice beyond the basics trying to wake up the students' scientific interest. Following Johnstone and Al-Shuailib [1] we must consider that Biology is a practical subject and so we must do laboratory work. The purpose of laboratory work is to teach hand skills and to illustrate theory.

2 METHODOLOGY

2.1 Design of laboratory training

Our experience is based in a complementary training in laboratory through all the student formation process. Two types of laboratories are used: the expository and the inquiry laboratories. In the expository laboratory the instructor defines the topic, relates it to previous work, and directs students' action. On the other hand, in the inquiry laboratory activities are inductive. They have an undetermined outcome and require the learners to generate their own procedures (Table 1).

Table 1. Descriptors of the expository and inquiry laboratory instructions.

	Descriptor		
Style	**Outcome**	**Approach**	**Procedure**
Expository	Predetermined	Deductive	Given
Inquiry	Undetermined	Inductive	Student generated

From Johnstone and Al-Shuailib (2001).

Given their different own nature and degree of responsibility of the student in each of the laboratory types, the process begins with the expository laboratory in the first course and continue, to the end of the academic formation, in the inquiry laboratory (Figure 1). For this reason the participation of the student in the expository laboratory is required within the curriculum while engaging in the inquiry laboratory is restricted to those students who voluntarily agree to it, we think as a result of the interest created in the first phase.

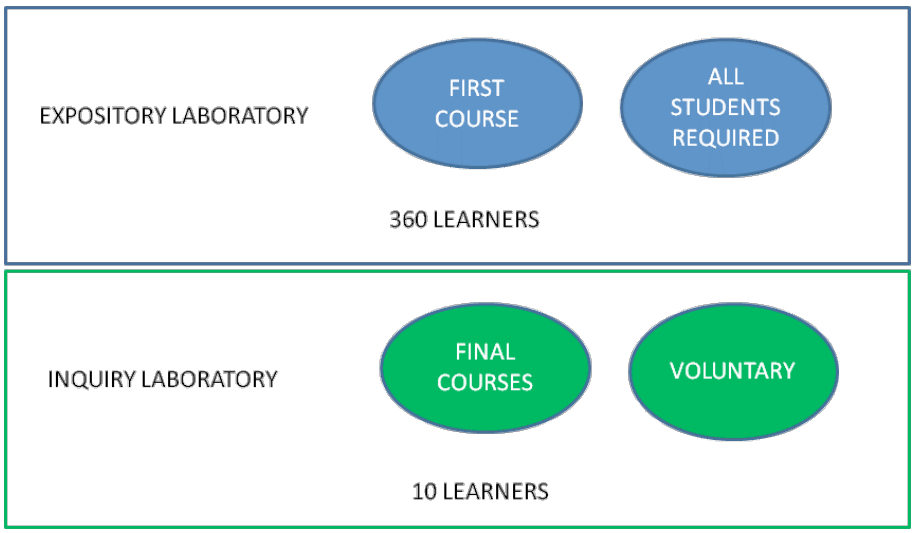

Figure 1. Design of a hybrid laboratory training between the expository and the inquiry laboratories.

2.2 Procedures

2.2.1 *Expository laboratory*

In the expository laboratory the students are provided of theoretical training on: laboratory safety, equipment and instrumentation commonly used in cell culture laboratories, methodology and best practices in cell cultures laboratories.

After students complete *in vitro* culture practices in the plant laboratory. Learners are given a script and all the material and instructions for the experiment (explants, culture media, etc..).

At the end students must answered some questions about the experiment (materials and methods and results sections).

2.2.2 *Inquiry laboratory*

In the inquiry laboratory we offer to learners the possibility to perform experiments in the laboratory and students must apply to participate.

By a personal interview we inform the students about their responsibilities and type of participation in this laboratory. Moreover, we inquire about the participant's interests and abilities.

At the end students make a poster presentation of their work.

3 RESULTS AND DISCUSSION

Laboratory work should aim to encourage students to gain [2]:

- manipulative skills
- observational skills
- the ability to interpret experimental data
- the ability to plan experiments

To these must be added the affective aims mentioned by Kerr [3]:

- interest in the subject
- enjoyment of the subject
- a feeling of reality for the phenomena talked about in theory

At the end the student should exhibit:

- appropriate manipulative skills
- the power to observe
- the ability to interpret observations and results
- the ability to plan experiments

The activities in the expository laboratory are performed simultaneously by a large number of students (20), with minimal involvement from the instructor, at a low cost, and within a 3-hour time span. The expository laboratory report, upon which the assessment is based, takes the form of a set of questions. By the answers to questions about the results of the experiment we can assume that the quality of them could be an indication of the manipulative skills of the student. But questions about materials and methods have to be shared to the students so they can appreciate what is important in the manipulative part of the laboratory. Nevertheless the expository laboratory make some kind of measurement of “the power to observe” and “the ability to interpret observations and results” of the student, but is not enough to handle the “appropriate manipulative skills” or “the ability to plan experiments” (Figure 2).

The activities in the inquiry laboratory effectively give to the student the ownership on the laboratory activity. This laboratory requires a joint work between instructor and learner allowing learners to formulate the problem, relate the investigation to previous work, state the purpose of the investigation and predict the result, identify the procedure and perform the investigation. The students can show improved attitudes towards laboratories and scientific research. This type of practical work can provide an environment in which many of the aims can be fostered, but it is time consuming (up to six months) and potentially costly. Therefore this laboratory must be restricted to few students (2:1; learners:instructor).

For a student to complete the training process in the two types of laboratory requires achieving their motivation and stimulus. The affective aims of the learner play a crucial role in this sense. Affective aims can be divided into two main categories; attitudes to science and scientific attitudes [4]. Attitudes to science include interest, enjoyment, satisfaction, confidence and motivation. Scientific attitudes apply to styles of thinking such as objectivity, critical-mindedness, skepticism and willingness to consider the evidence [5].

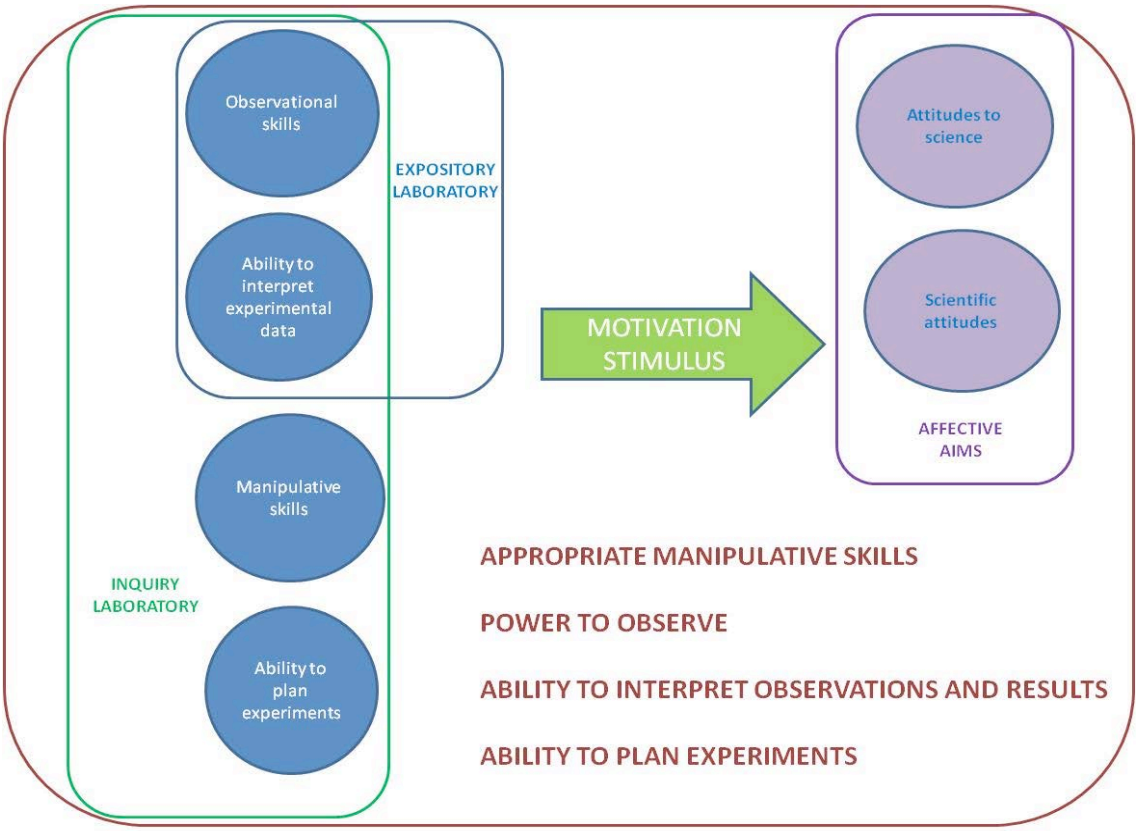

Figure 2. Results of the hybrid laboratory in Biology. Objectives (as specific statements of what the students should be able to accomplish as a result of being taught in the laboratory); Aims (as general statements of what the teacher intends to achieve) and Affective aims of the learner.

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