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The Research Strategy Needs to Dialogue with the Science Student

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ABSTRACT

The objective of the present work is to emphasize that although it is not possible to indicate a unique approach for the development of an investigation yet it is necessary for the student to analyze the chosen steps of a working plan. When students of both Biology and Medicine arrive at our laboratory to start a scientific research, away are in their minds the courses of introduction to scientific knowledge of the initial stages of their career. We analyze in the bibliography schemes and works that help the student and the responsible researcher to integrate student previous knowledge with literature focused on educational challenges and creative or critical thinking.
The present work provides the basis for a dialogue between those in charge of research groups and students who are starting their labor in scientific education and research.
KEY WORDS: *Science method, young researcher, education.*

INTRODUCTION

The objective of the present work is to highlight that although it is not possible to indicate a unique approach for the development of an investigation yet it is necessary to share or inform the student of the chosen steps.
Our research questions point to consider whether the intellectual tools that a student receives in the initial steps of his/her studies are sufficient to establish a research method and a working plan
We noticed that when students of both Biology and Medicine arrive at our laboratory to start a scientific research, away are in their minds the courses of introduction to scientific knowledge of the initial stages of the career. Student only remembers distantly hearing the names of Popper, Khun, discussions of Lakatos and descriptions of Feyerabend. So when it comes to think or put forward a scientific research, the student does not know "what path to take". We understand the philosophical disquisitions that accompany the evolution of ideas related to scientific thought [1,2], but this doesn`t merit leaving students in confusion.
The existence of this **problem** leads us to analyze in the bibliography for schemes and works that help the student and the responsible researcher to integrate the previous studies carried out by the student with his/her new research challenges and creative thinking.
Significance of the study**:** The present work provides the basis for an enriching dialogue between those in charge of research groups and students who are starting their labor in scientific education and research.

Situation Analysis

The student must understand the scientific context in which he is going to build up his work. For his/her progress it will be necessary to produce scientific publications and accumulate necessary data when requesting economic financing. We understand that there are other training skills (seminar communications, conference presentations, ethical values, theoretical content, etc.) but the group leader should explain to the student that the main weight of future assessments will be made on the basis of the scientific publications. This does not mean that we do not consider other skills valid, but it would be hypocritical to tell a student that he/she will have a secure future if he does not get annual publications. For non-Saxon students, it should be added that publications in another language, for example Spanish, do not provide solid background. This is not a judgment of value but the recognition of the environment in which the development of science moves and the evaluation criteria of the organisms that will fund their future positions.

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SCIENCE METHOD

It is well known that we cannot speak of a single science method, but it is not healthy to tell students that "The method is that there is no method".
The first behavior in which a student would solve this cognitive conflict will be to think that "anything goes". Let's take examples from literature and chess to illustrate this point.
For example: What strategy or method does Sherlock Holmes exercise? Is the style of Kurt Wallander better or more realistic?
It is interesting, but it is not the purpose of this publication, to compare the different working attitudes of the mentioned detectives. Someone may say that we chose characters from fiction but literature is a world created by man and, in a poperian way, has a real existence. It should be added that these characters are based on people known to writers. To summarize: all these detectives, within their circumstances solve or elucidate complex situations with different approach methods.
Moving on to chess, we see that there are different openings. Within each opening we can find great players and world champions. How to bless the opening Ruy Diaz in detriment of the Indian opening? "Deciding" or "blessing" a particular strategy or method would be to condemn us to a deficient search of the truth.

So, what to do?
Very simple. The responsible director should explain the method or guidelines chosen. Just as the chief advisor of a team must choose a strategy and face it or be responsible for it. It should be noted that Scientific Thinking includes a Decision Making activity.
A decision making "involves examining advantages and disadvantages, considering all of the steps of the problem solving, and evaluating the final decision in relation to available alternatives and consequences"[3].
Therefore the Director must make an epistemological decision. This is obvious to the director but not sufficiently explicit to the student. The director may have a lot of information about scientific methodology, but information alone can never replace a creative decision.
In my experience, after reading several applications and reviews in scientific journals publications like Nature there are a number of guidelines that scientists follow when making contributions to Science.
For each research situation the aim is to face something incomplete or that contradicts our cognitive structure and look for a new explanation that satisfies us [4].
Experiments may help to discard less plausible pathways or hypotheses.
An outline or method of investigation may be selected from the work of Elliot K.C. and collaborators [5]. In this remarkable work, besides considering different historical contexts, the dissimilar steps in the development of the Darwin Theory and in Ecology research where analyzed. From Figure 1 of Elliot K.C. work we have introduced slight modifications and considered the following working method (Figure 1):

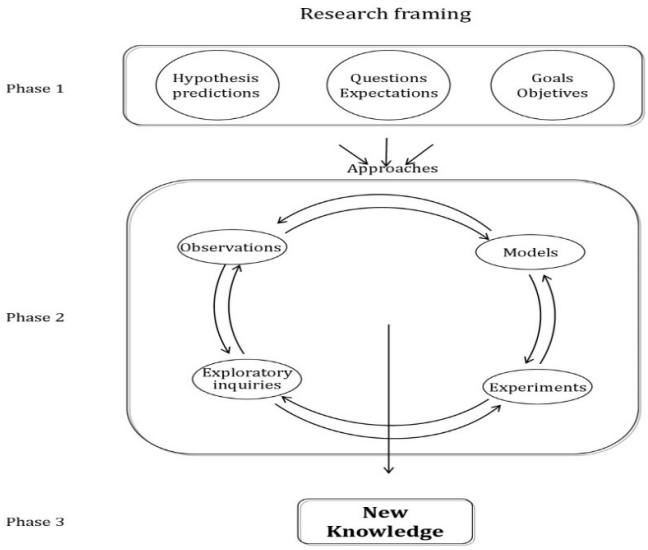

Figure1. Scheme for a scientific methodological decision.

We decided to relate the steps of Observation (O), Model (M), Experiments (E) and Exploratory Research (ER) in a cycle, similarly as the heuristic model sated by Rowland S.L. for Science teaching [6]. In general, in some subjects, we start through O and then we move to M or from M you go to E. The options are multiple but at some stage steps E or ER are performed.

The idea is that in many research projects there is a go and go by these steps until you get a reliable result. We can then divide the work into three phases:
A) An "Impulsive" Phase of Goals, Objectives, Hypothesis that mobilizes the research group.
B) A cyclic phase of laboratory "repetition" that produces results.
C) A final phase of verified, discussed, published knowledge that may have subsequent iterations and start like a new Phase 1.

We recognize, therefore, that another method may be chosen, but the director must explain his/her method. This should not be something obscure of which the student has no notion. The student should know the method even if it is a bad method. I strongly advise the director to hang or write on a blackboard what his method of work is, preferably in a visible place suitable for fruitful discussion. In this way the student will understand that it is useful to have a strategy or method that prevents us from sinking into a swamp.
We must bear in mind that for some projects the word hypothesis is a background or facts on which the objectives (general and specific) are built. That is to say that the hypothesis is assumed as a fact and it is not the idea of the work to refute it into the popperian way. In other projects, however, the hypothesis is a conjecture that must be tested. While the same word is being used from the operational point of view the meanings are different.
Finally we must consider that the cycle indicated in phase 2 is in accordance with the steps involved in active learning. Learning for efficient action includes action not just doing action recommendation [7, 8]

DISCUSSION

The next step we wish to consider is how this approach can be integrated with two papers that have had a great influence on the discussion of the Science methodology.
They are: "Strong inference" [9] and "Multiple working hypotheses"[10, 11].

In the first method described and published in 1897 it is established that the studies begin with the formulation of an assumption about possible answers or solutions to various problems. The working hypothesis can be defined as a plausible guess against a particular question. This item or step would be framed within our phase 1. Then from that hypothesis we move to cyclic phase 2. Some facts or experimental results are established with the help of observations, experiences or setting models.

The working scheme would be:

Hypotheses → observations, experimental models → knowledge

In the case of the multiple hypothesis method; each different hypothesis will "circulate" through phase 2 generating different results or knowledge. The scheme would be similar generating more results that will be evaluated, and in phase 3 the different hypotheses will be compared.

We should also think about the extended practice in research agency forms for subsidies when considering General Objectives and Specific Objectives. The General Objectives will be included in Phase 1 while the Specific Objectives will be different turns, repetitions or cycles within phase 2. It is worth adding that working on Phase 1 with Questions can elude the idea of refutation. Already Platt J.R. [9] has mentioned that the researchers do not base their works on the idea of the refutation.
A popular idea in the texts used by students but not so much in laboratories bench.

An advantage of this form of work is that the student can reframe everything seen in preliminary courses of Philosophy of Science observing advantages and disadvantages of his/her scientific method. This experience will allow him/her to contextualize or understand the reasons for the different discussions that have been generated about Science method. The student will understand that he/she must choose a scientific method in an analogous way we choose a way of life.
Only work and reflection on the path left behind will show the right method for every future circumstance. Until the method does not collapse, the student must stay true to it and only leave it when

he finds a better belief. Here´s a current advice regarding this notion from Argentinean scientist Florentino Ameghino (1854-1911):
"*A destroyed belief leaves in our spirit a great emptiness. We must not; abandon a belief until we replace it with another that is closer to the truth*"[12]

CONCLUSION

In this research we show that although there is no single method for research this is not the end point of the work but the beginning of a reflection on the method to follow.
This decision should be discussed and explained to science students in a way that allows them to incorporate their prior knowledge of epistemology into an active learning process.

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