Projects: that is the Question

Oswaldo Frota-Pessoa

Departamento de Biologia, Instituto de Biociências, Universidade de São Paulo, São Paulo, SP, Brasil

"Practicing for learning" is the basic rule of teaching. An apprentice in automobile mechanics, for instance, must get his/her hands dirty with grease from the very first day. Nobody has him/her sit at a desk and listen to a teacher's speech.

Such a rule, though usual at technical schools, is not common at other schools or in universities, where the old traditional motto is still strong: "Tell students how things are and test them to make sure they have learned something". Yes, they learn something: they learn how to do tests!

The project method should be the basis of teaching at all levels, besides being essential in the training of the biomedical researcher. It adopts and improves the philosophy of "learning by practice" and incorporates the problem solving method. Both methods are compatible with the way human intelligence works creatively. They consist in raising problems of interest to the students and make them think and act in order to solve such problems. If well administered, the project arouses the student's enthusiasm.

There are several types of projects depending on the teaching level and the nature of the subject. This facilitates its use in different circumstances. A project can consume part of a class, or last for weeks or months. The essential point is that it provides knowledge (informative objective) and at the same time mobilizes the student's mind and his initiative and action. As a result, the quality of their mental operations improves (formative objective). Knowledge should result from a highly rewarding, autonomous conquest which makes the students develop research strategies that tend to improve. The generalized use of the project method and the problem solving method in the teaching of science makes up the educational basis for the training of a researcher.

Rua Professor Guilherme Milward 68, 05506-000 São Paulo, SP, Brasil
E-mail: betefrota@sti.com.br
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PRODUCTIVE AND INERT IDEAS

Why is the traditional method so inefficient?

Either outside or inside school, in order to get to know and interpret facts, the students use the supply of notions they have gathered during their lives. These notions make up their model world. Such a model consists of more or less elaborated truths plus a great deal of mistakes and misunderstandings. For learning a new concept, the student compares it with those they have already assimilated. If such a comparison produces a compatible result, it is automatically incorporated in the model, so it can be used productively; otherwise, it can remain for some time as an inoperative belief easily forgotten. The traditional teaching, in which the teacher does all the talking and the students just listen, is a generator of inert ideas because the lecture makes it difficult for the students to compare what is being said with their own ideas.

The projects arise from problems that stimulate one's mind and make it work spontaneously. Besides, they often include practical activities which help students gather the information they need in real life situations. This explains the effectiveness of the project method.

EXAMPLES

The project method has been used, although restrictedly, in Brazil for over half a century. It was adopted at six old science teaching centers, such as Cecigua, in Rio de Janeiro, and by over a hundred groups of leaders who developed teaching and educational materials all over Brazil. Such groups were sponsored by Capes. It is also recommended by the new science museums, one of which is a part of the Oswaldo Cruz Foundation. So why does this strategy not become the rule?

The answer is that teachers themselves have been submitted, as students, to the traditional method for years and it became clear for them that teaching amounts to giving lectures and assigning tests. Not even pedagogy courses are able to undo the results of such brain washing. We hope for the success of the vigorous campaign of the Ministry of Education based on the National Curricular Parameters.

To pinpoint typical aspects of the project method, I will resort to some simple examples which I have witnessed over the years.

In 1935, I was a freshman in the Natural History course at the "Universidade do Distrito Federal" but did not receive any hazing because there were as yet no senior students to execute the task. The University had been founded that year by Anisio Teixeira and later became the "Universidade Federal do Rio de Janeiro". Anisio Teixeira had asked his advisers to find the best researcher in each area to be hired as a professor. Should the best one in Brasil not meet the requirements, he would send for a foreign researcher.

It was my first zoology class: Professor Lauro Travassos from the Oswaldo Cruz Institute walked into the classroom together with some of his assistants. He explained that the course would begin with the insects, which were easier to study, and told us we should collect specimens of ten different orders and draw their oral apparatus and their wings. Having said that, he bid goodbye adding that if we worked diligently we would be able to complete our tasks in time to attend his second class, scheduled for one month later. During the month, we worked feverously, using the material we collected on weekend excursions. Groups formed spontaneously that worked with initiative and creativity. The second class of Travassos began with his desk covered with boxes of slides and pinned insects for his approval. In the class that followed, he explained the evolutionary relations between the orders of insects, based on the evidence that we had collected in nature and studied in detail.

During his first class, Alberto Sampaio, from the National Museum of Natural History, projected slides showing families of plants of which few species existed in Rio de Janeiro and proposed that we form groups to study each of them. We soon plunged into the magnificent herbarium of the museum and launched our field work. This explains how, before graduation, I could publish, together with a colleague, our first scientific work, on the family Saxifragaceae. Carlos Viana Freire, assistant to Professor Sampaio, was beginning to produce his classification keys for families of plants, which were subsequently published as a book. We all collaborated with him by bringing from our excursions plants that required alterations of his keys.

In his very first class of genetics, Gustavo Mendes de Oliveira Castro, who worked with Adolfo Lutz in Manguinhos, gave us Mendel's paper to be read and discussed. I became so interested in the subject that I published in a local magazine an essay revising the notions about heredity in ancient Greece and Rome, as well as a mathematical analysis of Mendelism.

More recently I visited on the campus of Estacala, of the Autonomous University of Mexico, a course in microbiology taught entirely by means of the project method. The students chose, with guidance from their professors, their research themes. They consulted books and magazines and programed their activities. The professors gave the groups the necessary orientation, suggested bibliographies and commented on the progress of the projects but gave no lectures whatsoever.

The Methodist University of São Paulo offers a biology course which forms both biologists and school teachers. The students carry out successively short projects in groups in the areas of biodiversity, health and teaching. They are oriented by professors of different disciplines. The projects vary along the semesters until each student chooses the theme for an individual monography at the end of the course. Assisted by various tutors, the students, under supervision, practice teaching in primary, middle and high schools during the eight semesters of the course. They also give lectures and teach short term courses on applied science to interested adults. In addition they write scientific articles for the journals that the University publishes. Over the last years a number of the projects have been related to the needs of the community in the health and environmental areas. The students participation in such activities is actually giving them a precocious and gradual professional education related to the social reality of the community.

A specific project is going on in this room at this moment. Dr Coura is the tutor and we are the students. Dr Coura proposed, in pursuasive terms, that we develop the project "Educational Basis for Biomedical Research". We were motivated, being good students, to the point of neglecting other tasks and entertainment. Our team started out to discover the best way to form researchers. Every project should be followed by a report. Ours is now being discussed in class by the members of the team (the persons at the table) and their colleagues (the persons in the audience). It is also a typical characteristic of good projects that their reports be published so that others can adopt some of their proposals. Even this procedure was foreseen by our tutor, who is publishing a special issue of the *Memórias do Instituto Oswaldo Cruz* with our conclusions.

Let us now imagine – to our horror – that Dr Coura is a traditional professor. He would keep us in silence for about 50 minutes to tell us how scientists should be formed. Of course all of us would be jotting down notes, preparing ourselves for tests to come.

THE INICIATION TO RESEARCH

The scholarships to support the initiation to research for university students have been cre-

ated with the view to employ the project method as a basic lever in research training. However, such an iniciative must be restructured and expanded.

The granting of scholarships is undoubtedly worthy of merit, but what will become of the students who do not receive scholarships and who are additionally punished by having to swallow lectures which are uninspiring to them? Meanwhile, those who receive scholarships are awarded a two-fold prize, since they get a monthly pay in addition to the priviledge of taking part in projects.

The solution to such a paradox depends on two common sense precepts. First, the participation in research projects should be extended to all students regardless of their having a scolarship or not. Second, the scholarships should be reserved for students who are financially needy.

It is usually thought that teaching by means of projects for all the students in the university courses is unfeasible. This is because the initiation in science imitates the model of the graduate school courses. Both the master's degree and the doctorate are long term projects. The projects in the undergraduate courses have the same methodology basis, but should be short and numerous and carried out in teamwork. The initiation to research is a specific task of the university courses and should encompass all the students by means of suitable strategies.

Being a trainee in a laboratory, no matter if one has a scholarship or not, is a desirable activity for the students intending to become researchers and obtain advanced degrees. It is good for them to participate, during the last years of their university course, in the activties of a laboratory of their choice. Their work should not however be confused, as sometimes happens, with that of a technician who carries out routine work and is renumerated for it. The applicant for a post as a trainee should choose where he intends to work in accordance with his preferences and the reputation of the laboratory.

PROJECTS IN REGULAR COURSES

The undergraduate course should adopt a type of project method which differs in various aspects from the activity of the scholarship holders for scientific initiation.

The students in a class should work in teams on several short term, successive projects. It is important that the subject of the project and its elaboration be decided in group discussion. It is also recommended that the project should be related to the current subject matter of the course. In addition to stimulating the groups, the tutor will raise problems and provide the sources for finding a solution. The evaluation of learning should be based more on achievement than on tests.

From Einstein to our students, it has always been true that all of us think more effectively when we start out from particular cases that interest us and try to understand them and find out their causes. This inductive process leads us to more and more general principles. From these we arrive at the explanation of new facts deductively, increasing our knowledge and improving the quality of our mental strategies.

In this way starting with the fall of the apple, we arrive at the superstring theory, which endeavors to explain the mystery of the universe.