PHYSICS TEACHING IN THE 21ST CENTURY

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Abstract
The aims of physics education have evolved alongside the society in which we live, to be able to adapt to the rapid pace of change imposed by the application of scientific discoveries in the industry. We could define the quality of physics’ teaching as its ability to learn how to reason. This approach covers both teaching competency-based and is student-centered. Each topic should be an excuse to teach how deduce it or induce it. The teacher decides if he/she deduces it or induces it from a demonstration or from experimental data. Experiments allows us to appreciate the ability of reasoning of the students, since they need to combine all they know in conducting the experiment. To evaluate the learning of a topic, we need to write questions to test the required reasoning, that it is not easy. PISA succeeds for students 15 years old, the challenge is to do it with our students.

Keywords: Quality in education, deducing, inducing, reasoning.

INTRODUCTION

Role of Education
The aim of education is to prepare the citizens for the activities necessary to ensure its survival and progress. Education systems have evolved by trial and error, arriving at similar results in the majority of countries. Some countries perform well, as measured by their economic development and tests that assess knowledge of segments of the population. Education must help to solve current problems and reduce future problems; This leads us to consider the current global problems, that we need to solve in the near future.

State Of Affairs At The Beginning Of The 21st Century
To predict the development of any human activity, it is necessary to consider the conditions in which we are at the beginning the twenty-first century. The 20th century produced the greater technological change which has been observed, creating devices belonging previously to science fiction. The device that has changed our way of life is the personal computer, present now in many of our homes. Cell phones are evolving by merging with the computer applications, in the future a single device will meet both computation and communication functions. Internet as a means of communication and creator of social
networks, it is a new way to disseminate the news outside official channels, forcing Governments to be more honest. The scientific-technological research is which has changed our habits and needs, through the development of new technologies. But technological development has created new problems, such as global warming, the Arab spring, etc. The population growth leads to problems of food production, scarcity of water and the depletion of oil reserves. All these are interrelated problems, which creates unexpected side effects, so we need try to solve them.

The population growth needs of more energy, transportation and water; it has increased the oil consumption that lead to the depletion of the reserves. In this century is expected a peak in production predictor of the exhaustion of the wells, which implies the need to find alternative energy sources. A side effect of the consumption of fuels is the increase in CO2 in the atmosphere, which absorbs the infrared radiation emitted by the Earth's surface (solid or liquid), producing an increase in the temperatures of the Earth's surface. Oil has many uses, in agriculture is used to move tractors and combines, in the production of pesticides and fertilizers for crops, the pumping of water for food and in the big cities far from sources of fresh water. To reduce consumption, the price of crude oil will continue to rise; that will make affordable the exploitation of wells currently considered depleted.

In 2011 the world's population reached the 7 billion people. It is remarkable that the population in Europe already does not grow, and that in Africa it grew close to 5 times since 1950 and grows increasingly rapid. Analyzing by countries, it shows that in developed countries already does not grow its population and in the others it grows. Many procedures are proven to reduce the birth rate in many countries, but evidence shows that raise the standard of living, through a good education, it has that desirable side effect. We need to improve their standards of living, bringing education within the reach of their population; including health and employment options that allow them to have better income improving their self-esteem.

Predictions for the 21st Century

We can expect that in the 21st century to stabilize the world's population. Continuous improvements in health care have increased the duration of human life, which we expect to exceed 100 years. A numerically stable population requires that the different means of production of material goods for a reasonable standard of living also remain stable over time, long-distance goods transportation will be unaffordable, which will lead to changes in global consumption patterns. The food will be produced near the centers of consumption, big cities of more than a few million inhabitants to reduce size due to the excessive cost of transporting food for its inhabitants. We expect thousands of centers of consumption (cities) surrounded by food-producing areas, cooperate among themselves via the Internet to share solutions to common problems; forming a kind of global Confederation of cities. Wars will disappear, leaving only security forces to maintain public order. Large global companies dispersed its factories, to meet the needs of the local consumption Center. The recycling of components will be used with great intensity, reducing the needs of non-renewable components. Personal capital will be relatively small, and the wage gap will be much lower than today. The standard of living of industrial or political leaders will not be very different from the normal population.

Alternatives for This Evolution
In the future we can expect that the flow of information make the planet a community (as the current European Union), the fast development of the rational use of energy and the recycling of materials, will be disseminated and shared using Internet. In the future, the scarcity of hydrocarbons will reduce the use of airplanes. The few goods will be transported in electric vehicles or on boats. Government posts should not generate wealth, and the possibility of denunciation on social networks reduce, in fact, cases of abuse of power.

Another possibility is to follow the path of natural growth of world markets, with the consequent accumulation of wealth, which probably leads to wars to seize the last drops of oil. Some countries have tried to improve the distribution of wealth through strong systems of Government, with the best intentions, without achieving its objectives

All countries have education systems, but with different results. It is remarkable that countries with very good educational systems, such as Finland, achieve good standards of living for the majority of its inhabitants, which leads to think that education is a factor of positive change. The problem is how to achieve an education that allows each person to develop productive activities compatible with their vocation. Now supply and demand of the markets decide how many people are required in each productive activity. In a stationary population, this does not seem a good mechanism. Preparation opportunities should be in accordance with the needs of the population. In the future the graduates of a college should have employment at the end. This means proper selection processes that allow a fair chance for every one of the citizens. The educational process must contain a strong dose of vocational training and democracy.

Expect from Education

We need more research to develop alternative energies, genetic development of improved seeds that can be grown without intensive use of pesticides and fertilizers, inducing rains and recovery of waste water, etc. We need to change the quality of education, to ensure that people can apply their knowledge in the solution of the problems of the society in which they live. There is a relationship between the education of the population and their standard of living, indicating that education spending is a profitable investment. But not always, some countries with a large expense on education, have poor results in their education according with the PISA test measures (Program for International Student Assessment). PISA measures reading comprehension ability and ability to reason from certain data, does not measure memory. PISA today represents a commitment by the country members of the Organization for Cooperation and Economic Development OCED to better understand the operation of their educational systems and provide new bases for political dialogue and collaboration in the definition and adoption of educational objectives and competencies that are relevant to adult life. A good education is that which teaches reasoning, to acquire the necessary skills to apply their knowledge in the solution of the problems of the community.

With the development of new technologies are being created new job opportunities, although the disappearance of others with many years of seniority is also produced. The invention and development of the mechanical clock allowed us to measure time very accurately, but the development of electronic clocks based on a crystal oscillation frequency stability, has made them obsolete. New watches are much cheaper and more accurate, making that they tend to disappear the manufacture and repair of mechanical watches.

Research in The Teaching of Physics
Until the mid-twentieth century research in physics education was in institutions dedicated to Humanities and Sociology, which also were responsible for the training of teachers, with emphasis on studies of didactic and pedagogy. With time, the notion that you cannot teach what you do not know begins to be accepted. If he is going to teach Physics the teacher needs to know Physics, a necessary but not enough condition. Of the Natural Sciences: Physics, Chemistry and Biology, Physics has the dubious honor of being the most hated by the population in general; perhaps due to the high of its rate of failure, especially in the Baccalaureate level. Trying to reverse this situation, years ago, the efforts of the best educators were combined with the best scientists in the Physical Science Study Committee PSSC, to write a textbook, books for teachers, laboratory equipment for experiments and audiovisual materials as a complement. Initially the result was excellent, but in 10 to 20 years, the initial impulse was lost, and the Physics returned to the previous indices of acceptance (or failing). There were other similar attempts with similar results.

Over time it was accepted as a field of research valuable for physicists, Physics Education, with many universities (in the United States) with Physics departments; who founded Institutes dedicated to researching the teaching-learning processes of Physics. Currently, all levels of education are researched and there are specialized journals in the field of Physics Education. Many of these universities have short courses for teachers to apply their research results in teaching practice. How to do that has been mentioned by McDermott (1990), Hestenes (1997), Zeilik et al (1998), Moreno (2009) and Meltzer and Otero (2014). Also, they can be taken remotely Tobacyk et al. (2005). Published results tends to be very favorable to new procedures compared with traditional classes Marshall and Dorward (2000) and MaclIsaac (2010). They have come to Mexico as "teaching by competences", trying to make the student competent in the application of his knowledge to his problems. Another very popular version is the teaching "by questions", McKeachie, et all (2005) I have synthesized both versions in teaching reasoning, taking advantage of the fact that "understanding causes pleasure"; This pleasure is my best didactic tool Riveros 2014. The most recent innovation refers to the Flipped classroom (2019), in which the student reads the material to be learned at home and in the class does what would be the homework to do at home. The teacher advises him only when he needs it. In fact, I have used the inverted teaching for more than 20 years, giving the students the questions that will be used to evaluate their reasoning, for in class, helping them answer those that cannot solve on your own. In each chapter I ask deductions or inductions, and a few numerical problems solving some interesting application; writing 25 to 30 questions per chapter. Procedure that I have tried since 1998, as evidenced in Riveros, H.G. (1998) Electricidad y Magnetismo: Preguntas y respuestas, México, Editorial Trillas.

The existence of the Internet has radically changed the teaching-learning process. Education is measured through essentially memorized assessments, but with the Internet any student has access to a gigantic memory; we have to teach reasoning to interpret the sometimes-fake data of the Internet. Before the Internet, attendance at the school was essential, where a teacher taught the subjects of the course and the student demonstrated his knowledge through periodic evaluations. At school he learned subjects from Kinder to Bachelor, Master or Doctorate. At the end of the twentieth century distance courses began, in which the student can study at home, when it seems more convenient; using texts and audio and video recordings that help you learn. There are teachers who can answer the questions that the student cannot answer, when they ask for it. On the Coursera (2019) website there are free university courses.

In the future, since work at home has increased productivity, reduced transportation problems in cities and increased parent-child interaction, children will be preferred to learn at
Kindergartens will continue to function as day care centers and for children to socialize. With few elementary schools, since most parents prefer to take charge of their education; the same goes for secondary and preparatory schools. Normal schools, teacher educators will evolve in research centers on learning processes, where audiovisual materials that are distributed for learning at home will be designed. Its main activity will be to find demonstrations and experiments that can be done at low cost and/or with home materials, reducing the need to create laboratories for experimental activities that are considered essential. Given that the different regions of a country have different resources and problems, it is necessary to design the appropriate learning activities; there are no universal application courses.

The aims of the teaching have evolved together with the society in which we live, from a memory-based education to one that teaches reasoning, to be able to adapt to the accelerated rate of change imposed by the application of scientific discoveries in the industry. We have a society in continuous learning, which requires the ability to reason and adapt quickly. There is a lot of talk about quality in education, but everyone defines it in a different way. Here we are defining the quality of teaching as its capacity to teach reasoning, which allows it to be measured as in PISA (2019). Each theme of the program is a pretext to teach to deduce or to induce, which are the two types of reasoning known. In the last 50 years the laboratory instruments are completely different, whatever we teach to use, it becomes obsolete in a short time.

PISA tests shows that, in all countries, basic knowledge is practically the same. They differ in the History and Geography that are specific to each country, but the basic knowledge of reading and writing, mathematics and sciences are global. To combine learning at home with face-to-face teaching, the same assessments need to be used in both systems. The curricula can be translated into sets of questions that allow to measure the measurable reasoning in the evaluated subjects. These question banks need about 20 times more questions than those used in an evaluation; what allows to choose at random by computer, the evaluations that measure all the required subjects. It will be necessary to periodically update the reagents, to consider the scientific and technological discoveries that may occur. The main advantage of exams carried out by evaluating institutions is that the student will ask the professor his doubts about the topics that will be asked in the evaluations. I learned that, when I gave private lessons, the students told me this I do not understand the teacher; but if I am in my class, the student tries to convince me that he knows everything because I am the one who qualifies him. It is preferable to be the good guy who teaches him to be the bad guy who qualifies him.

Since Physics is a science based on experiments, it is necessary to review the programs of study of Elementary, Middle, High School and bachelor's in physics subjects looking for examples of activities or experiments that can be done at home, with the help of a computer connected to the Internet. The computer came to stay and is an element of communication that allows the existence of social networks that currently turn the world into a global village. A fundamental part of the educational process, especially in Experimental Physics, is teamwork, in problems that require the cooperation of experts in various disciplines; as are most modern problems.

Communication via the Internet, with image and voice (Skype or Hangout) allows communication between groups, observing the experiments, sharing data; but, above all, the interpretation of the same data. This way of interacting we made it around a table, and now we do it around computers. These activities should be part of the educational process,
including problems that require simultaneous experiments, complementary data and other activities that encourage group work. The evaluation of the ability to solve a problem through an experiment will continue to require the presence of the student in a laboratory, for the activities in which this capacity is indispensable.

Experimental Physics research changes as new instruments are developed as Technology evolves, but no major changes are expected in what we call the Scientific Method; the research methodology has not changed in the essentials. Most of the experimental equipment is controlled by computers, we can expect this trend to be maintained since computers continuously increase their capacities; that is, its speed and the size of its memory.

Due to their type of work, the scientists interact socially with their students and with their colleagues with whom they exchange professional knowledge and suggestions. As human beings, they depend to a greater or lesser degree on relationships with relatives and friends, with whom they meet frequently. Social networks maintain these contacts, although they do not always favor face-to-face contacts. Skype communication is almost face-to-face communication, since you can see the faces and body gestures that help in the communication without words established in face-to-face contacts.

Examples of Educational Methodologies

To say that we teach reasoning is compelling; but it is much better to clarify it through some examples of how it can be implemented in a subject known to all. We can use the teaching of the Principle of Archimedes as an example of different ways the teacher can choose to impart his knowledge: Memorize: "Anybody submerged in a fluid experiences a vertical upward thrust, equal to the weight of the fluid. displaced by the body", Deductive: Consider a volume V in the middle of a fluid at rest, this volume V of fluid has a weight P due to the gravitational pull of the Earth. Because it is at rest, the pressure at each point of the fluid is constant, the net force exerted by the fluid on the volume V must compensate exactly for its weight P, because otherwise volume V would be in movement. It is possible that this was Archimedes reasoning when he made his discovery. Inductive: Through an experiment in which we simultaneously measure the displaced volume and the change in the weight of the object. With a graduated cylinder we can measure the weight of a volume of water to verify that the clean water weighs one gram / cm³. Inserting partially a cylindrical object into the water and measure the increase in the reading of the balance (force on the object) and the volume of water displaced in the graduated cylinder, showing that the weight of the displaced water is equal to the thrust on the semi-submerged cylinder.

Teaching by competences: It is about teaching the student how to apply their knowledge to solve their problems. Problem at elementary school: Calibrate a dynamometer made with several leagues. We want a dynamometer that measures up to 30 grams with a resolution of 1 gram. Hanging a cylindrical object weighing 30 g of a league we observe how much is stretched. If we can read how long the chain is stretched, with a precision of one millimeter, we need to stretch at least 30 mm to have a resolution of 1 g in the dynamometer. If you stretch less, we can lengthen the league by putting several in series to achieve the desired stretch. We can obtain the calibration curve of the dynamometer by hanging known volumes of water, or coins of a Mexican peso with a mass of 4.0 grams each. Student-Centered Teaching: It requires knowing the student's background, including the socioeconomic ones, to be able choose the most suitable methodology for the student. It is very efficient, but difficult to apply if the group is of many students. In a study carried out in several universities in the
United States, trying to find common factors in how their best teachers taught (according to the Vox Populi); they concluded that the most important thing was that the teacher would be enthusiastic about the subject taught. We can then recommend that the teacher choose the methodology with which he feels most comfortable, that should help him show enthusiasm for the subject. Video https://www.youtube.com/watch?v=AjPUqUGOTl4&feature=youtu.be.

**Flipped Classroom:** The teacher prepares notes, giving the students the necessary information to understand a certain topic. He also mentions some tasks to do in class, which allows the teacher to advise him or guide him in the solution of the task to be done. The roles of the house and the class are reversed, at home we study what was seen in class and in class what is left as homework. In my inverted teaching version: For each chapter of the syllabus, I write 25 to 30 questions that allow me to measure if the objectives of reasoning and/or resolution of relevant problems were achieved. Before each class, I give them the questions to answer, so that they read my book or the one they like most, which prevents me from repeating what they have already read. Analyzing question by question, I answer the questions, or they answer them in their desk. By posing the question so that everyone can solve it from their place, it is possible to review the student preconceptions in a few examples, in a very efficient way; giving personal or group explanations, depending on the case. It is a constructivist and personalized teaching.

**Experiments for Elementary School**

Build a scale (dynamometer) to be used in solubility experiments. The table salt has a solubility of 36 g in 100 ml of water at room temperature. A dynamometer with a capacity of 50 g and a resolution of 1 g is enough. Rubber bands can be used since they withstand forces of more than 50 g.

Construction of the scale of rubber bands: Rubber bands 7-8 cm long and 2 mm wide and thick, stretch about 5 mm with a weight of 50 g. With 10 g they stretch 1 mm, but we want a sensitivity of 1 g; so, it is required to use 10 leagues in series, which can be easily tied as shown in the photograph. To calibrate the scale, we can use clean water, if we have a container calibrated with 10 cc. The 1-peso Mexican coins have a weight close to 4 grams. As a recipient of the objects to be weighed, a plastic bottle hung from a yarn with a paper clip. The length of the rubber bands is measured with a tape. Adding 1 coin each time, the calibration line shown in Figure 1 was obtained.

![Figure 1. Calibration curve for rubber band scale](image-url)
Problem 1: Measure the solubility of the salt. Find how many grams of salt dissolve in 50 ml of water.

Materials: Container with flat bottom. Diameter of 8-10 cm so that it has a lot of area to evaporate. It can be a disposable yogurt or cream container. Water 50 cc, Salt 20 g in 4 packs of 5 g, Spoon to dissolve the salt.

Procedure: Place 50 cc of water in the beaker. Add the first 5 g of salt and stir with the spoon until they disappear. Another 5 g are added that also disappear. Another 5 g are added that also disappear. When adding the last 5 g of salt it is no longer possible to disappear, even if the solution is shaken. The water dissolved the maximum amount of salt it could at the water temperature.

How can we measure how much salt is dissolved in the solution?

Let the glass with the salt dissolved for 5 minutes at rest, so that the excess of undissolved salt settles in the bottom of the glass. We weigh the container with a flat bottom, on the scale. In the flat bottom container, empty without stirring the solution, without taking any of the salt settled on the bottom. We weigh the container with the recovered solution. We leave the container half covered, so that it does not fall dust and evaporate in 1 or 2 days. When evaporating, only the water comes out as steam, the salt precipitates from the solution in the form of crystals. The slower the evaporation, the more beautiful the recovered salt crystals are. Weighing the dry container with salt, we can calculate the weight of the evaporated water and the weight of the dissolved salt. Water at room temperature dissolves about 0.36 g of salt per gram of water.

Collective experiment Estimate the salt content in chicken broths of different brands. They are available in cubes of about 5 g or powder, from which 5 g can be taken. Children are asked to do so with the chicken broth used in their home.

Problem 2: Estimate which brand of chicken broth cubes have more salt?

Materials: Container with flat bottom. Diameter of 8-10 cm so that it has a lot of area to evaporate. It can be a disposable yogurt or cream container. Water 50 cc, Salt 20 g in 4 packs of 5 g, Spoon to dissolve the salt, Chicken broth cube or 5 grams of chicken cube powder, A coffee filter or a compact cloth to filter the solution.

Chicken broth contains substances insoluble and soluble in water. To separate them dissolve the chicken broth in 30 cc of water in the glass to dissolve. It can be heated to 40 °C to facilitate dissolution. First weigh the filter or rag and the flat bottom container. The filtered solution contains the soluble materials, including table salt. The filter is allowed to dry to weigh how much insoluble matter the chicken broth contains. The flat bottom container is weighed with the solution and the water can evaporate for one or two days. The slower the evaporation the larger the white crystals of salt will be, Figure 2. The dark green substances are the nutritious components of the chicken broth. Compare your results with those of your colleagues who used other brands.

![Image](image_url)
**Figure 2.** Crystals of table salt obtained by evaporating cubed chicken broth dissolved. The black stripes are millimeters of a ruler.

*Experiment for Middle School*

Archimedes principle. The principle of Archimedes can be induced by placing a graduated cylinder half full of water on a scale. By introducing a cylindrical object into the water, it can be verified that the displaced cubic centimeters are equal to the weight change in grams measured by the balance.

*Experiments for High School*

Sound Analyzer A sound analyzer is a device that uses a microphone to record sound, measuring its volume in decibels at a certain sampling frequency. The computer is a laboratory tool, which requires transducers that measure the variables of interest, in this case a microphone. Audacity is the name of a free digital audio editor and recorder that can be downloaded from //audacity.sourceforge.net. It can be useful in many experiments, but let's think of two:

1. Measure the speed of sound in an aluminum rod If we support it by its center of mass, and we give a blow at one end to excite longitudinal waves of pressure, we hear that a sound is produced, and its intensity slowly decreases with time.

Doing the experiment with an aluminum rod ½ inch in diameter and 1,216 m in length, we obtained the sound intensity of the fundamental mode under 15 decibels in 30 seconds. By doing a frequency analysis in a 2 second interval close to the stroke (initial) and 30 seconds later (2 seconds at the end), figure 3 was obtained.
Figure 3. Frequency analysis of sound initially and after 17 seconds. After 17 seconds the rod vibrates in its fundamental mode, the other frequencies are almost damped.

Measuring several times to estimate the uncertainty, a fundamental frequency of 2064 ± 10 Hz is obtained, which coincides with the 2060 given by the frequency analysis. If the fundamental mode makes half wavelength (λ/2) equal to the length of the rod, a propagation velocity (longitudinal wave) of 5003 ± 25 m/s is obtained. We can compare this value with that of 5000 m/s reported for thin aluminum rods in the Handbook of Physics and Chemistry published by Rubber Company.

2.- Bouncing ball. Bouncing balls produce a sound every time they hit the floor. Measuring the moment in which the sound pulse associated with the impact with the floor begins, the duration of each rebound can be measured (if the time the ball lasts in contact with the floor is disregarded). If there is no lateral displacement during bounces, the flight time is twice that of the equivalent free fall. For free fall $x = gt^2/2$, if we call $A$ at the maximum height reached and $T$ at the duration of the flight, then $t = T/2$ and $A = gT^2/8$.

We can measure with the cursor on the normal screen of Audacity the start time of each bounce and write them in a column in an Excel table. Calculating the difference between two consecutive times, we obtain a second column with the times of flight $T$. In the third column we can calculate $A = gT^2/8$ that calculates the height neglecting the friction with the air (which we have already found negligible with video cameras). Since the maximum potential energy is at maximum height and equal to the total energy, if we calculate the quotient $A_2/A_1$ we obtain the energy ratio before and after each shock, which indicates the amount of energy dissipated in every bounce.

Measuring with a hollow hard plastic ball, the data of figure 4 were obtained, where the decrease in height is observed in 39 consecutive bounces. Changes in height show small deviations from the smooth curve that joins them, the energy loss in each shock is almost constant, and close to 10% of the initial energy, that is, it bounces with 90% of the initial energy.
EXPERIMENT FOR UNIVERSITY

Air Rocket - Using a two-liter disposable bottle and 30 cm of half-inch PVC pipe for water, a rocket launcher can be assembled; taking advantage of the fact that the tube fits in the bottle (inserting 2 cm). The rocket is constructed with a flexible plastic or acetate with the area of a letter-sized sheet, rolled over the PVC tube forming a tube 28 cm long and that can be closed with masking tape. To shoot it, it is necessary to sit down, place the bottle between the knees, hold it in an upright position and close the knees with maximum speed so that it acquires a vertical speed. The flight time is a measure of the initial speed with which the rocket is fired.

To calculate the movement the simplest model is parabolic shooting, limited to the vertical. This is neglecting the friction with air, of a long object (0.28 m) and low mass (0.015 kg). The next model would be to put a friction with the air proportional to the square of the speed. With a flight time of 2.8 seconds, the maximum height is less than 9.6 m.
Figure 6. The video data can be adjusted to a parabola in time \((x = t)\).

From the equation in the figure we could deduce that in this example the friction introduced a constant force, which reduced the acceleration of gravity from 9.78 to 8.58 m / s^2, calculated value by deriving the expression twice for \(y\). This interpretation is false, the friction with the air does not reduce the acceleration of gravity. The first 5 points define a line with slope \(m = 11.6\) m / s (initial speed) and the last 7 points are on another straight line with slope \(m = 8.68\) m / s (final speed). This result could be interpreted as reaching terminal velocity, when the weight equals the friction force. It can be shown that terminal velocity is still not reached.

CONTRIBUTIONS

We define quality in teaching as its ability to teach reasoning. This approach covers both competency-based and student-centered teaching. Each topic of the program is a pretext to teach to deduce or to induce. The teacher decides if he deduces it or induces it from a demonstration or experimental data. Demonstrations help to induce the pleasure of understanding, since they tend to present divergent phenomena. Finding assessments that allow reasoning measured, helps the teacher to find the best strategy for learning. If the student has all the evaluation reagents, he does not feel frustrated in the exams. The distribution of the questions to be answered before the class allows the student to read the book that seems best. He reads at home what the teacher would give in class, and in class can solve with the help of the teacher, the questions that would be his homework. The experiments allow us to appreciate the ability of students to reason, since they need to combine everything they know in the realization and interpretation of them. But it is only appreciated being the teacher of laboratory, anyone can repeat what a book says, but not everyone can explain an unexpected result in an experiment. After performing experiments that solve problems, interpret them and communicate them, you feel the pleasure of understanding something; which is a powerful didactic tool. We may want to investigate
another problem, which hooks us into a very satisfying activity. It is very nice to work on what causes us pleasure.

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