HOW TO TEACH PHYSICS IN OUR DAYS – THE EARTH AS AN OBSERVATORY

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Abstract

The work of physics teaching has changed with the utilization of new technologies like the computer, video films or the use of internet. With the internationalisation of the universities and students coming from very different countries it is very clear that the learning of physics can be very different when we receive students coming from different parts of the world. We want to present the differences found in the teaching of physics and the consequences related with students mobility. Another problem is related with the use of our planet as the subject of our study using physical laws.

Key words: *teaching physics, new technologies, students mobility, planet Earth, laboratory*

1. INTRODUCTION

The utilization of new technologies like computers, video films, internet, mobile phones or calculator machines, changed the ways of teaching physics, and the type of lessons used in our schools. The new way of life occurring in our days, has changed the vision of the world by our students, including the nature of the world where we live, and, sometimes, it seems that the new technologies can substitute the real observation and the study of the real world where we live, the planet Earth. As soon as we know, our civilization, must solve, in the near future, two important problems that, if not solved, can put in danger our way of live and perhaps our existence in the planet. One of these problems is related with the energetic needs and the use of the different types of energy we know. This problem includes the knowledge of the mineral and fresh water resources in our planet. The second problem is related with climate change, pollution of the planet, and future consequences of our present acts. It is very important that our students acquire some knowledge about these problems and the ways we can try to delay the inevitable and try to minimize some problems. The new technologies are used everywhere, in our days. They can give a good help in the diffusion of knowledge. Unfortunately our students can obtain easily video films, they have access to internet at home, in the schools, gardens, public transports, etc. The access to internet using mobile phones and the diffusion of all types of computing games, can retire the innovation in the classes where the computer is used, and the innovation is the principal way to obtain the attention of our students in some classes.

2. PHYSICS-AN EXPERIMENTAL SCIENCE

It is known that in the last years, the number of physics and engineering students in diminishing. The reasons related with this problem are different, in different countries and in different parts of our planet. One of the problems is related with the fact that it is necessary to have some mathematical knowledge to study, analyse and interpret data related with physics phenomena. Another problem is related with the need to use laboratory work to teach physics. Sometimes, it is difficult to have useful laboratories related to the subjects to be studied. Traditionally, the study of physics, was related to the presentation of some concepts, the enunciation of some laws and some numerical applications (problem resolution) without making the connection between the concepts and laws studied and the real world. The use of some videos can give some help, to show some aspects we need to solve, but we must be aware about video content and the level of knowledge of our students. If a video is done for USA needs, we must have some care when trying to use it in an Asian or African country. The knowledge and experience of live of the students must be different. The existence of commercial programs trying to simulate some details or parts of our world, and some problems we must solve, can give us the wrong idea that they can substitute the observation and the necessity of making measurements in the nature, and the need to know what to make with them. This means that the data

obtained must be analysed. The computer is programmed by the man, and the data introduced can be affected by some sources of error. We must have an idea about the results we must obtain. Another problem is related with the problem we must choose. In order to obtain a good result, we must choose the adequate program, but it means that we want to know exactly the work that must be done by the computer. The analysis of the real world or the experience in the lab, must be tried, before the use of simulations. I remember that, many years ago, I had a group of students that did not know that the lines they used to plan the connection between different elements in electric circuits, were in fact copper wires, because they didn't worked with them on the lab, they had only made the scheme, in the paper. For these students there was no relation between the scheme they made in the classes and the electric cables they have in their houses, necessary to have electricity to illuminate the house and to "put on" all the electric devices used in their homes.

The need of having theoretical classes, sometimes with an elevated number of students, and their division in small groups in order to make work in the laboratories and to solve some problems, can be a problem for the student make the association between what happens in the different types of lessons. In my University, the presence of the students in theoretical lessons is not compulsory. This means that the student can go to a class projected to solve some problems related with subjects discussed previously but he never discuss because he did not came to the class. The same can happens in the laboratory work. For making a good work in the lab, the student must know what to do, why to make it, the measurements he need to take, how to use the data obtained and, with the teacher help to be able to analyse the results obtained, to verify if something is wrong in the work and , for higher level students, to make suggestions about the ways of improving the job.

Another problem we have with our students is the wrong idea about the use of the computer and/or calculating machines. A typical problem is related with the elaboration of a graph, sometimes using data obtained in the laboratory work. The students want to make the job with the use of a computer, and, in principle, that is a good idea, but how to use correctly the program they have in the computer? How to choose the scales of the axis and put them on the program? Is it necessary to use the same scale in both axis of the graph? It is usual to see some graphs occupying all the computer screen and having the points related with the work done, in a small and very located region, making the analysis of the data impossible. When the graph is well done, we have the problem of the interpretation of the data. All the programs related with graph construction can made the adjustment of a straight line to the points of the graph. The method used is purely statistical, but in the nature, in the real world, the things can be different. We can imagine a graph of the distance travelled by a car as a function of the time interval needed to do it. If the car was stopped at the initial instant, we know that the distance travelled at that instant is zero, but the computer do not know this, and the line that appears in the graph do not pass by the point named (0;0), the origin of the scales of the graph. This can be a real problem, because the programme used must be adjusted to our problem and, in general, our students do not know how to solve it. There is also another problem related with this one. We are saying that we must think about the validity of the results obtained with our computer. They have the wrong idea that everything obtained using a computer is well done and we have no need to make questions about it. The computer is a machine and the man says to it what must be done. If our order is incomplete or has something not well done, the results can be a disaster. The same problem happens with the calculator machines. When trying to solve a problem using a calculator to make the calculus need, it is necessary to look to the value obtained and to see if it agrees with our knowledge about the problem we are studying. When the teacher says that result obtained for a given problem is wrong, the answer is always the same "I use the calculator to do it, how can it be wrong?".Who introduce the data in the calculator?. Who said the calculator the operations needs to solve the problem? Are you sure that you use the parenthesis in the order needed for the calculator works properly?

This means that the physics teacher in our days much teach the students about the advantages of using computers or calculator machines, but they must teach the students how to use them, how to choose the problem we need to solve a particular problem, and the most important thing is that the computer is a machine we use when we need but he never substitutes the knowledge we have about our problem, based in the observation and interpretation made about what happens in the world where we lives.

Another important aspect related with the physical laws is the fact that they are theoretical models, and they work in ideal conditions. In the nature the situation is different, and, sometimes, it is necessary to make adjustments between the theoretical law and the data, to have the real solution we try to obtain.

1.1.Physics and the new technologies

In our days, it is very easy to obtain some types of data and information that were inaccessible in the past. We need to be informed about the places we must check to obtain the type of information needed. The teacher must have the necessary actualization to be able to distinguish between the information advisable to use and the "noise" we must discard. The "Open Educational Resources" we can find in the internet can be used sometimes, but we have the problem of the speaking language, the quality of the resources we can find and the need to have some kinds of technologies, that can not be found everywhere.

The physics teacher must know how to use the new technologies and how to convince the students to use them properly. The use of the internet by our students could give us a good help, but, when we try to put them to use it to make some type of research we see that they don't know how to use it. The use of electronic platforms by some schools can give a good help in the coordination of our work with the students. They can be used as a place to put all the information related with some discipline (programs, summaries of the classes, dates and works for evaluation, material that must be used during classes) but they can be used also to put materials to study, subjects related with the course that can be discussed by the students, activities that can be used in the evaluation of the student, etc. They can be very useful, particularly with student-workers that have some problems related with timetables in the University. In the teaching of physics we have a great problem. The platforms can not substitute the laboratorial work. A student can learn how to use the different instruments, working with them. The work in the lab must be learned in the lab. Of course, we can never forget that the principal lab we have in our world is our real world.

1.2.Physics and "our world"

As I said a student of physics must be able to see and analyse the world where it lives. This sentence must be analyzed with some care. A young student living in a great city does not have the same vision of the world that a student living in the country. Sometimes it is said, as a joke, that our children know the animals they heat from the vision they have on the shelves of the supermarket. The connection between them and the animals they saw in photos or pictures is made, sometimes, very late, after making a visit to some educational farm, with the school or the family. For the student living in the country this knowledge is made in the beginning of their lives. They saw the animals since they birth, they know that the animals must heat something that must be cultivated and they knew that some day they will be killed and eaten by someone. The same can be said about the observation of the sky. They knew very early that we have stars in the sky, the bright spots that can be seen at night, and they can see that one of them is very large, the moon. The children living in the cities acquire this knowledge in the school, from the books, films and sometimes a visit to a planetarium. I am not saying that is better to live in the country than in the city, but the teacher must be some care when teaching young students.

Coming again to the resolution of some real problems. We must consider that some of them can not be solved using only physical knowledge. In fact when we try to study our world we must study very complex phenomena related with physics, chemistry, biology, geology, etc. Mathematics is a useful tool used everywhere. A tentative is being made to solve this problem with the so called interdisciplinary research groups. They are groups formed with people with different specialities, trying to solve the same problem. Sometimes the problems can be simple and can be solve by a group of researchers of one speciality when they have some knowledge related with others specialities. This is one of the reasons because we have students of physics that wants to proceed their studies in different disciplines like biochemistry, biology, geology, applied mathematics, doctors, engineers, etc.

3. PHYSICS AND THE SOCIETY

The study of our planet by official organizations of different countries, universities and some private organizations show that our society must solve in a near future two important problems. One of them is related with the energetic needs of our civilization and the ways we are using to obtain that energy. Related with this problem is the fact that some of the materials of common use in our society and exploited directly from our planet are close to exhausting. The other problem is related to climate changes, ice fusion in the glaciers located especially in Greenland and Antarctic continent, and the pollution of our planet. All these problems are related with physics studies and its study should be a concern and an objective of our students. In fact, in my country, I do not see the young generations worried with a tentative of solution of this type of problems. This is a problem related with the teaching of different ways of studying our world without making the connection between them. Our young students see the different disciplines as some special boxes where we try to put the problems after appropriate classification. The boxes are closed and there are not a possibility of making some connections between them. It happens that some students, in the first semester of the course, speaks to me that some subjects they believe to be object of study of Chemistry are studied in the university in classes attributed to the department of Physics.

Physics is a discipline that we must study when entering the university and makes the registration in another course. Sometimes despite being a discipline from the first semester of the course, the approval needed is obtained in the last year of the course. Studying physics involves the use of mathematics, something they do not like, the need of work in the lab and make the written reports of the work done with the analysis and related conclusions needs to have free time to make these jobs. There is also the problems that must be solved, sometimes using tables of data, and making the calculus with a calculator. When the job is practically finished the teacher says that is necessary to think about the result and to see if it is consistent with the theory. Another problem is related with the attention needed in the calculations. A mistake in a sign can invalidate the solution obtained.

All the problems cited involves the need of work during all the semester, the necessity of paying attention to the work they are doing and the capability of analysing results and make connections between mathematics and physical world.

When someone tries to speak with our students about the problems cited in the beginning of this work, they show up to be uninterested . There are many people in the world studying that problems. If the problem is so urgent why the governments do not encourage the study of these problems and the media does not talk just about them? This is a selfish way of our young people to face the future and let others solve their problems. This is a social problem related with the way as our young people lives, how they solve their problems, and the decisions they made. The great majority of our students do not solve their problems. There are someone (the parents, the teacher....) who solves them. As a rule, they do not make decisions. For some of them, it is a problem to choose the timetable they want when entering in the University. They never do that type of decision.

3.1.The interchange of students and teachers

In my country (Portugal) the mobility of Portuguese students started, many years ago, with young teachers from the Portuguese Universities, that went to another countries to obtain a Master or a PhD degree. The studies were, normally, related with areas without researchers in Portugal. Special attention was given to areas like Atomic and Nuclear Physics, Condensed Matter, Astrophysics and Particle Physics. We did not have, at that time, students coming from another countries and studying in Portugal. Now, the situation is completely different. There are many agreements between different countries and Universities and many programs to interchange students and/or teachers.

3.1.1 Teachers from foreigner countries

The need of making international calls to fill the places of University Professor, and the differences between the work, research conditions and the quality of living in the different countries of the world, contributes to the existence of Professors from different parts of the world in the same Department of a University. We can mention two principal problems related with this fact. The first is related with the language used for teaching. In my country, all the foreigner teachers declare to learn Portuguese and to improve the knowledge of the Portuguese language in order to teach in Portuguese, but, sometimes, it is very difficult to attain this objective. The second problem is related to the introduction of these teachers in the Portuguese society. The problem can easily be solved if one member of the family of the teacher is a Portuguese citizen. The existence of children that can go to the school with Portuguese children is also a way of integration. Now, a new problem appears. Teachers of foreigner countries are occupying places of decision in the universities. They don't know the country, they are coming from a different society, the way of solving the problems can be very different, and that can be a great problem.

3.1.2. Students coming from other countries

When we speak about receiving students from another countries, the problems can be very different, depending on the country of origin of the student, the "real" language he speaks, the culture , religion, etc.

The programs related with interchanging students, make rules related with scientific knowledge, hours of study, types of classes, etc. In fact, this is not enough to solve the problem and make the integration of the student in the University. I can give an example: If we receive, in Portugal, a student coming from Spain or Italy, we know that, in general, we will not have problems, Society and cultural problems can be easily overcome and the problem of the language can be solved with an intensive course. When we receive students coming from India or Pakistan, we know that some problems must be solved. They do not eat in the canteen of the University, they do not share the residence room with an European student .Cultural habits are very different and these students try to isolate themselves. The problem of the language can be very complicated. Usually they speak English, and they are coming to obtain a Master or a PhD Degree. In these type of courses it is relatively simple to convince the other students to have classes in English, but, sometimes, even with classes in English it is very difficult to help them, in order to understand what the teacher tries to do.

Another problem related with students coming from countries outside the European Union is the scientific knowledge of the student. Sometimes a detailed analysis of the curricula says that the students must have some classes with students from a lower degree. In general the students receives well this type of decision, but, the classes they must frequent have an elevated number of students and sometimes it is impossible to work with lectures in English (last year I had a student coming from Bangladesh, and the discipline he must frequent had 65 students, and with him, 66 students. In the first class he said to me that he did not understood anything I said and the class must work in English. The other students did not want lectures in Portuguese and I must solve the problem with him using another methodology). I must say that this student likes very much to study in our University, and, this year we have 4 students from that country.

Another group of students are those coming from countries that officially speaks Portuguese. The problems differ from country to country and, sometimes, are related with the University of the origin of the student. Sometimes we have cultural and religious problems related with these students. The existence of women between the Professors related with the course can be a problem related with some countries and religions professed.

3.1.3. Portuguese students going to other countries

A great number of Portuguese students uses a semester of it's course to go to another country, using, most of them, the ERASMUS program. The great majority of students choose countries from the European Union or located in Europe. In general they don't have problems, they are received well by the students, and the population they need to meet, and they are well succeed in their studies. In fact the scientific knowledge acquired is low than in Portugal, but the student has the opportunity to know another people and another methods of work, and it can be useful in the future, because in our country is very difficult to find a job at the end of a university course. They can also make connections in order to obtain a Master degree or a PhD. The great exception occurs with some Engineering courses that have employers looking for young students to work in their companies, but the number of students in the courses is reduced because they need to work with physics and mathematics.

3.2 How the society looks to the interchange of students and teachers

The Portuguese society receives well those coming from another countries. In small cities, like Évora, located inside the country, the existence of foreigners is noted, but, in general, people are friendly and tries to help. The University staff tries to help and understand the students when they are coming. It is frequent to find the ladies from the bar trying to teach to foreigner students the name of the things they want to buy. The excuse is always the same " in the University they have someone saying what they want but when they are going to the city they must know the names of the food, so they must speak Portuguese". In the students residences and outside the University, some of the students must have some precautions. Religions involving different habits can be a problem when our room is shared with another student with different habits. In these cases praying hours can be a problem. A person eating using the hands without tableware is not well seen. It is considered a lack of hygiene. The Portuguese law gives the same rights to women and men. This means that students can have women responsible for teaching some matters in the course they chosen. When a student decides to study in Portugal it must accept the rules of the University and the laws of the country he choose.

4. THE SCIENTIFIC PREPARATION OF THE STUDENTS

The rules adopted by some countries, including those of the European Union, related with the types of lessons and hours of work related with each discipline, the programs and some works related with the course of the student, can give a great help in the analysis of the curricula of the students coming from other countries. Unfortunately, there are another countries were the information is not detailed and, sometimes, we receive students that want to obtain a master degree, but , when we try to begin the work with them we discover that their scientific knowledge related with the subject of the chosen course is quite different from the idea obtained with the analysis of the documents presented when they tried to be accepted in the course.

There are some countries where the teaching of physics consists in presenting some concepts, deducing and enunciating laws, and, sometimes, making dimensional analysis. These students don't know how to work in a laboratory, they never make measurements, they don't know how to choose the meter needed to obtain the data necessary. These students don't know how to use the laws studied to solve problems that can occur in our world. They don't know how to analyse the concepts and the laws they enunciate. The use of computers or calculating machines to make some calculus can be a great problem for these students. They never used them and they don't know how to analyse the results and see if they are consistent with the values predicted. The mathematical knowledge of the students coming to study physics it is also a serious problem.

The problems enunciated can be overcome with more work by the student and more time to obtain the desired degree, but, sometimes, students do not have willpower to solve this type of problems and they have time constraints due to scholarships. The integration of these students into working groups can lead to delays that will prejudice the rest of the group. The Universities are trying to solve this

problem imposing previously the need of frequency and obtaining the minimum rate necessary to proceed the studies.

5. SOME FINAL COMMENTS

The interchange of students is a reality in our days. By interchange I am saying that my country receives students coming from another countries and there are Portuguese students that are going to study in other countries. The countries that receive our students are not necessarily the countries of the students we receive. The interchange of teachers is something that occurs rarely. The social and cultural problems related with the presence of the students from different countries can be overcome. Problems related with language can be solved, in general, but there are some cases considered exceptions. In some cases students are faced with different lifestyles and different ways of studying physics. In their countries of origin there are not suitable laboratories to the studies they seek, and we do not know how they will use the knowledge acquired. European students are those that give rise to minor problems, from the social and cultural point of view and from the scientific point of view.

The globally society and the schools, in particular, do not give the necessary attention to some problems which, if not properly studied, may threaten our way of life in the future Studies related with the physics of our globe (internal globe, oceans and atmosphere) must be improved but something must be changed in order to get the attention of our young people in order to want to know what is happening to our planet and how to try to be prepared for possible changes related to the way we live, the materials we use to, and, if necessary, changing the local where we live to elsewhere in the higher regions. Another problem that needs to be solved is related with the energetic needs of our civilization. These studies must be done looking for the future, and, of course, must involve politicians and worldwide centres of decision. The study of these problems is interdisciplinary.

Solving this problem involves the organization of programs and teaching modes made in schools. The study has to be integrated in the lives of our students and must reach the largest possible number of young people, starting in the elementary school. This means that teachers should update their knowledge and techniques of teaching. Of course that work must be done with government support.

The media can play an important role in the proper dissemination of existing technologies and the way we should proceed as means to minimize the problem. Talking about energetic needs does not mean just talking about the need for electricity. There are various methods related to the heating and cooling buildings, which can be used, spending a minimum amount of electricity. The need to preserve the planet for future generations causes us to worry about the pollution associated with some forms of electricity generation.

Scientists, politicians and businessmen must unite trying to solve a problem that belongs to all of us. The planet needs our help. We can not think in our country separately because the problems we face are related to all of us.

REFERENCES

References do not appear in the text. This work was written based in the work of the author as a professor in the Évora University and as a researcher related with renewable energies and a specialization in Geophysics.