FFP12 2011
Udine 21-23 November 2011

TEACHING MODERN PHYSICS FOR FUTURE PHYSICS TEACHERS

E. F. Nobre, A. O. Feitosa, M. V. P. Lopes, D. B. Freitas, R. G. M. Oliveira, M. C. Campos Filho, *Federal University of Ceará, Campus do Pici, Fortaleza, Ceará, Brazil*
N. M. Barone, R. Monteiro, M. F. S. Souza, *Virtual Institute-Federal University of Ceará, Campus do Pici, Fortaleza, Ceará, Brazil,I*

Abstract
In this work we present a new way for teaching Modern Physics to students of course for teachers formation. One of the great difficulties faced by the teachers of the secondary schools of the State of Ceará, in Brazil, may have its origin in their formations during the undergraduate courses. We aim to offer a course in modern physics so that future physics teachers can transmit this knowledge to their future students in a clear, simple way and with good results, awakening in their future pupils the interest by the study of Sciences in general and in Physics, in particular.

1. Instructions
Since year 2000, when Modern Physics was included in the program of examination for entrance of students in the Federal University of Ceará (UFC), the secondary schools began to include Modern Physics into their programs. The big problem was that this inclusion has been made simply Since year 2000, when Modern Physics was included in the program of examination for entrance of students in the Federal University of Ceará (UFC), the secondary schools began to include Modern Physics into their programs. The big problem was that this inclusion has been made simply as an appendix to the contents of the third year of high school, almost in the end of the school year. In addition, many teachers were not familiar with this subject and thus the inclusion of Modern Physics was compromised.

Aiming to help solving this problem, we developed a discipline of Modern Physics to be applied to students of the Undergraduate Course in Physics from the Federal University of Ceará (UFC), sponsored by the Virtual UFC Institute. The course is specific for training teachers in pre-service and is applied to 5 cities in the State of Ceará. The Virtual Institute of Federal University of Ceará (Virtual-UFC), besides creating, implementing and maintaining the technological core, organizes the physical structure, logic and the educational progress of each course. All over the world, the electronic learning (e-learning), a model of teaching based on the online environment, leveraging the ability of the Internet for communication has been an excellent way to open the University to the student's home, allowing a high degree of flexibility in any academic program. There is no doubt that the multimedia technology is a powerful tool in the development of e-learning contents, which is inserting deep changes at higher education [BAGGALEY, Jon; KIRKUP, Gill]. The use of e-learning mediated by the Information and Communication Technologies (ICTs) in the educational process, has favored the inclusion of a contingent of people in higher education, contributing to increase places in higher education. This work is part of project developed at the Learning Environment of the Virtual Institute of the Federal University of Ceará, in Brazil, called SOLAR. The most part of courses which are being developed in this e-learning environment are focusing on the teachers formation. The production of teaching materials for e-learning plays a more significant relevance role than those ones we use for presence courses. In this process the steps of planning, construction, mediation and evaluation inherent to the traditional teaching, plus the endless possibilities of combining the diversity of information available and the benefits of interactivity, flexibility and dynamism favored by the ICTs require the implementation of this material in a more safely way. We must consider that the students are not face to face with their teachers, so they need a material absolutely clear and easy of understanding. By developing the didactic material that is used at the distance courses, the didactic transition of the Virtual UFC, uses as a

methodologic reference the socio-interactionism (FIORENTINI, L). In this context, the education becomes a dynamic task that allows to the students, themselves, the active construction of their knowledge, according to their experiences in different situations where they liveby the Virtual UFC Institute. The course is specific for training teachers in pre-service and is applied to 5 cities in the State of Ceará. The Virtual Institute of Federal University of Ceará (Virtual-UFC), besides creating, implementing and maintaining the technological core, organizes the physical structure, logic and the educational progress of each course. All over the world, the electronic learning (e-learning), a model of teaching based on the online environment, leveraging the ability of the Internet for communication has been an excellent way to open the University to the student's home, allowing a high degree of flexibility in any academic program. There is no doubt that the multimedia technology is a powerful tool in the development of e-learning contents, which is inserting deep changes at higher education [BAGGALEY, Jon; KIRKUP, Gill]. The use of e-learning mediated by the Information and Communication Technologies (ICTs) in the educational process, has favored the inclusion of a contingent of people in higher education, contributing to increase places in higher education. This work is part of project developed at the Learning Environment of the Virtual Institute of the Federal University of Ceará, in Brazil, called SOLAR. The most part of courses which are being developed in this e-learning environment are focusing on the teachers formation. The production of teaching materials for e-learning plays a more significant relevance role than those ones we use for presence courses. In this process the steps of planning, construction, mediation and evaluation inherent to the traditional teaching, plus the endless possibilities of combining the diversity of information available and the benefits of interactivity, flexibility and dynamism favored by the ICTs require the implementation of this material in a more safely way. We must consider that the students are not face to face with their teachers, so they need a material absolutely clear and easy of understanding. By developing the didactic material that is used at the distance courses, the didactic transition of the Virtual UFC, uses as a methodologic reference the socio-interactionism (FIORENTINI, L). In this context, the education becomes a dynamic task that allows to the students, themselves, the active construction of their knowledge, according to their experiences in different situations where they live.

2 Methodology and discussions

The material concerning of Modern Physics was developed by a team composed by a Professor, who was in charge of all the contents of Physics; Educators, experts at Pedagogy who are in charge of the Didactic Transition (DT) and technicians in ICT. This last team is composed by specialists in various areas of computing who use the multimedia technologies in order to transform the texts written by the Professor in e-materials. So, each class presents animations, retractable texts, vector animations, links to additional readings, chats, forums, and all kinds of resources currently used in digital technologies focusing on education. The use of these tools enables the integration of various resources in a single learning environment, and encourages the adoption and understanding of audiovisual language. Our main goal is develop e-lessons in order they are presented to the students in a very clear, simple and attractive way. Nevertheless our structure is developed based on the idea of the use of on line material, all materials of the virtual courses of the UFC, are available on line and in printed form for the students.

The course was developed in six lessons covering the following topics: Special Relativity; Thermal Radiation and the Origin of Quantum Theory; Atomic Models: Thomson, Rutherford, Bohr; Wave-Particle Duality and the Principles of Quantum Theory and Nuclear Physics Topics. The teaching material was structured in order to bring a bit of History of Physics in all contents. In some subjects, we developed animated lessons, with audio. In all classes the subjects were presented with simulations, animations, music, challenges that were intended to excite students to seek solutions to challenging problems, suggestions of sites for complementary reading and research

and much supporting material, discussion forums, chats and an special virtual space called portfolio, where the students presented the solutions of the exercises. In nuclear physics lessons we also developed a special tool called Dynamic Book, which are virtual books to complement the covered topics. The structure of lessons is showed below:

Lesson 1: Special Relativity – 8 Topics

- Topic 01: Galileo´s Transformations Review
- Topic 02: The Michelson-Morley Experiment
- Topic 03: The Postulates of Relativity; Simultaneity
- Topic 04: Time dilatation
- Topic 05: Space Contraction
- Topic 06: Lorentz transformations
- Topic 07: Relativistic Dynamics - Relativity of mass
- Topic 08: Relativistic Dynamics: Energy

Lesson 02: Thermal Radiation and the Origin of Quantum Theory – 5 Topics

- Topic 01: Black Body Radiation - Principles
- Topic 02: Black Body Radiation - Theory
- Topic 03: Photoelectric Effect, The Quantum Theory of Radiation
- Topic 04: Compton Effect
- Topic 05: X-Rays

Lesson 03: Atomic Models I – 4 Topics

- Topic 01: Thomson Model
- Topic 02: Successes and Failures of the Thomson model
- Topic 03: Model of Rutherford. Experiment Rutherford Planetary Model
- Topic 04: Successes and Failures of the Rutherford model

Lesson 04: Atomic Models II - Atom quantized Model – 4 Topics

- Topic 01: Atomic Spectra, Spectrum Series, Bohr's Postulates
- Topic 02: Electron orbits, the Hydrogen Atom
- Topic 03: Energy Quantization
- Topic 04: Successes and Failures

Lesson 05: Wave-Particle Duality - 4 Topics

- Topic 01: de Broglie Waves
- Topic 02: Diffraction Particle
- Topic 03: Principle of Uncertainty
- Topic 04: The Wave Function

Lesson 06: Topics in Nuclear Physics - 4 Topics

- Topic 01: The Nucleus
- Topic 02: Nuclear Reactions
- Topic 03: Radioactivity
- Topic 04: Radiological Risks to Health

The lessons were developed in order the students could use the new multimedia technologies with the use of computers and the internet, but besides these virtual recourses, the students had six meetings at presence moments with their Teachers/Tutors during the application of discipline. There was one Teachers/Tutors for each city. These teachers/tutors, some of them are specialists in Physics Teaching, some with Master's degree in Physics and some finishing his doctoral degree, accompanied the students during the time that the lessons are applied. This team of Teachers/Tutors was coordinated by the same Professor who produced and wrote all the material and by the Coordinator of tutors, a Professor whose function is to monitor the progress of the work of Teachers/Tutors. In addition to face meetings, the students were oriented at a distance by their teachers/tutors through the discussion forums, chats, and all the resources currently available by the digital technologies.

The method of evaluation of the course in e-learning is different from what is done in traditional courses. In this course the students were evaluated personally and virtually. The students had several small conceptual evaluations at the end of each face meetings with their teachers/tutors.

The goal of these evaluations was to provide students a better understanding of physical concepts. There was no math in these evaluations. Besides these small tests, the students did a big test which required physical concepts and also the mathematical tools. The virtual evaluations were distributed among the six discussion forums and the six lists of exercises solved by students and posted on the solar environment. The final average was formed with the results of all evaluations: in presence and virtual evaluations. For the student who did not achieve the minimum average, a kind of GPA (Grade Point Average) required for approval by the University, was offered a final exam: an written exam covering all topics studied. In addition to the material produced especially for this course, the students were guided to consult also some basic textbooks of Modern Physics (Acosta, Beiser, Eisberg-Resnick, Serway, Tipler). In addition to basic textbooks on the subject, the student also received a printed manual containing all lessons that were available on the website of the course. This greatly favored those students who still not have a computer in their homes.
The results of 31 students who participated of this project were excellent. The most of them was approved with A concept and there was a minimal dropout. These results are showed in figure bellow.

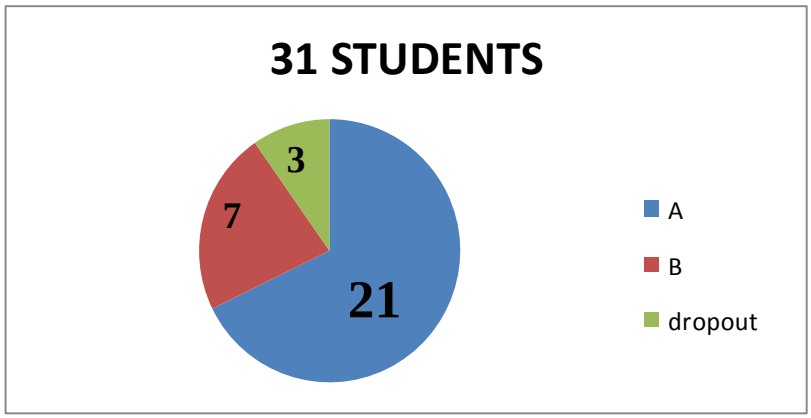

Figure 1. – General results of all students

3 Concluding Remarks

As a result of this way of teaching Modern Physics, we obtained one of the best results so far, since the beginning of the Physics Course in 2007. The students felt truly attracted by this subject. The abandonment was minimal, the frequency in the meetings was almost total and participation in activities was massive. The results showed approval ratings in the discipline between 80% to 100%. Next year, first half of 2012, we will apply the lessons of Modern Physics to all students, around 11 cities, involving about 100 students. We hope that the project will have again the same acceptance by the students and they are as successful as were the students of this first class. Another expected result is the involvement of students who attended the course acting as monitors in the next application of the project in 2012. Playing a role as monitors of the discipline, they will act under the guidance of teacher / tutor of the class, helping the new students, answering questions, forming study groups, which may bring greater benefits in learning. We also expect that helping to colleagues, may promote a consolidation in student learning that will act as a monitor.

References

Acosta, Virgilio; Cowan, Clyde L; Grahan, B. J. Curso de fisica moderna.. Mexico: Harla, 1975. 512p
Baggaley, Jon; Hoon, M., Ng Lee (2005) Pandora's Box: Distance Learning Technologies in Asia, Learning, Media & Technology, v30, (1)
Beiser, Arthur. Concepts of Modern Physics. 3rd ed. New York: McGraw-Hill, 1981. 533 p.
Eisberg, Robert, Resnick, Robert. Quantum Physics of Atoms, Molecules, Solidas, Nuclei and Particles, John Wiley & Sons Inc., 1974. 928p.
Fiorentini, L. E Morais, R. (2000) Languages and interactivity in distance education, São Paulo, Brazil. P&D,

Kirkup, Gill; Kirkwood, Adrian (2005) Information and communications technologies (ICT) in higher education teaching: a tale of gradualism rather than revolution. Learning, Media and Technology.

Serway, A. Raymond, Moses J. Clement, Moyer A. Curt. Modern Physics. Saunders College Publishing, 2ª. ed. 1997. 666p.

Tipler, Paul Allen. Modern Physics. Rio de Janeiro: Guanabara Dois, 1981. 422p