

Distance Training for Physics Teachers in Pspice Simulator

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Abstract

In this paper, we focus on how to qualify the physics sciences teachers in terms of integrating the computer simulation while teaching the physical concepts. The distance learning platform used is an effective alternative to continuous training happening in the face-to-face mode. Indeed, while the conventional training is limited in time and space, the proposed solution allows overcoming its problems, while taking into consideration the real needs of physics teachers. The training is in agreement with collaborative learning features: Therefore, teachers are invited to build their knowledge in the simulation software to solve the students learning problems by cooperating with each others.

Keywords: physics sciences; integration of the simulation; teachers; Distance learning; platform; collaborative learning

1. Introduction

In the era of knowledge society, the Information and Communication Technology (ICT) occupies a central place in the world of education. These technologies are often proposed as a solution to the teaching and learning problems. Morocco is not an exception. Formally, science teaching is one of the genes of the Moroccan educational system. Research has shown that Morocco's performance remains behind other nations, ranking 40th out of 45 educational systems (Ministère de l'Éducation Nationale (MEN), 2008). Another research insists that science education in Morocco is facing several challenges; chief among these is the students' poor performance in physical sciences (MEN, 2009). Despite these findings, the Ministry of Education shows great interest in the integration of ICT in education, since it is aware that this integration improves the quality of teaching and learning (MEN, 1999). As such, an ambitious program for the generalization of Information and Communication Technologies in Education in Morocco (GENIE) was developed. It aims to achieve the Ministry's policy towards the effective integration of ICT in teaching practices. However, on the ground, a large gap between expectations and achievements still exists: few teachers integrate ICT in teaching physics (Alj & Benjelloun, 2013). This low rate is due mainly, according to the previous exploratory research, to three obstacles. The first one is the lack of physical facilities within schools, second is the lack of software and applications adapted to programs taught, and the third is the need for qualification and teachers training. Thanks to the efforts of the Ministry of Education, the problem of equipment is largely resolved. Techno educational qualification of physical science teachers is the key to effective integration of ICT in education. It allows these teachers to master simulation software and the creation of educational resources suitable to programs taught. However, the trainings of teachers are of very short durations and are far away from the mastery of software simulation and optimal integration of the software in the teaching of physical phenomena (Alj & Benjelloun, 2013). In this situation, distance learning is more than necessary, due to its flexibility which eliminates the time and space constraints.

In this paper, we focus on the qualification of physics teachers in terms of the integration of simulation in the teaching of physical concepts. We propose an alternative solution to address the problems of conventional teacher training using a distance learning platform while taking into account the real needs of teachers of physical sciences. The training is based on collaborative learning: Teachers are invited to build their knowledge in simulation software to solve their students' learning problems in collaboration with other teachers.

The rest of the paper is organized as follows: Section 2 addresses several related works; Section 3 discusses the added value of simulation in the learning process; section 4 focuses on the agreement of the collaborative learning with our training; Section 5 presents the methodology used throughout this work. Section 6 presents the reasons to choose

the Pspice simulator and the Moodle platform. Section 7 describes the general structure of our training. Section 8 presents our model of educational resources in UML; and section 9 concludes the paper and provides some future directions.

2. Literature Review

Several studies have assessed, in general, the integration of ICT in the profession of the teacher (Anderson, 2004). Peraya, Viens & Karsenti (2002) emphasize the need to take advantage of the value added (pedagogically) with the use of ICT. In Morocco, Droui, El Hajjami, Bouklah, & Zouirech (2013) found the positive effects of problem-based learning by integrating ICT and simulation in the most appropriate situation for optimal learning results. El Yaakoubi, El Jamali, Bahra & Talbi (2006) have shown in their research a strong willingness of physical sciences teachers for integrating computer simulations in their professional practices, as they are aware of the importance of this tool in the development of their learner's performance. Other researchers emphasize that the simulation is a good example of incorporating ICT in the experimental sciences (Ahaji, El Hajjami, Ajana, El Mokri & Chikhaoui, 2008). However, most research on the use of computer simulations has been approached without consideration of the possible impact of teacher support, the lesson scenario and the role of computer simulation in the program (Rutten, van Joolingen & van der Veen, 2012). These factors may increase the performance of learners in the acquisition of concepts and physical phenomena. High school students got remarkably better results in learning the characteristics of an optical lens base using computer simulation compared with the traditional approach (Chang, Chen, Lin & Sung, 2008). Other researchers have found that simulation is a source of constructive feedback; it helps students to identify and correct their misrepresentations in the field of electrical circuit. They also noticed that the simulation increases students' confidence and enhances their motivation to stay in their learning process (Ronen & Eliahu, 2000). Other research has shown that the production of digital content by teachers is very limited (Lablidi, Nachit, Abourriche, Namir & Talbi, 2013). The same research found a high correlation between well-trained ICT teachers and the educational content production.

3. Simulation

One of the weaknesses of classical training is that it often provides information without concern for its practical application to the real word (Saravit, 2006). For this reason, educators attempt to benefit the added value of computer technology to develop simulations of real word situation for helping students learn about real word problem situations.

3.1 Definition of the simulation

Simulation is the experimental reproduction of real conditions in which should occur a complex operation. It is also the representation of an object by an analog model that easily can be studied (Banks, 1998). The simulation is to provide a model of the phenomenon that we want to study, to observe the behavior of this representation when varying its parameters and to induce what would happen in reality (Ndoumatseyi Botongoye, 2012). In science teaching, there is a lack of interaction between the theoretical world where the student manipulates notions and concepts, and the practical world where student manipulates appliances and concrete materials. The simulation can be considered an intermediate level between the theoretical models and the physical manifestations of the studied phenomena (Richoux, Salvetat & Beaufils, 2002).

3.2 Definition of computer simulation

Computer simulations are based on computer programs containing a simplified model of a system. Computer simulations based on the implementation of theoretical models used to study the function and the properties of a system modeled and to predict its evolution (Severence, 2009). In the educational context, Alessi and Trollip (1991) describe the simulations as follows: « A simulation is a powerful technique that teaches about some aspect of the world by imitating or replicating it. Students are not only motivated by simulations, but learn by interacting with them in a manner similar to the way they would react in real situations. In almost every instance, a simulation also simplifies reality by omitting or changing details. In this simplified world, the student solves problems, learns procedures, comes to understand the characteristics of phenomena and how to control them, or learns what actions to take in different situations » (p.119)

3.3 The types of simulation in education

Alessi and Trollip (1991) identified four distinct types of simulation:

- Physical simulations: Students learn skills from a simulation of physical objects;
- Procedural simulations: Students learn skills from operating systems;
- Situational simulations: Students learn skills from playing certain roles;
- Process simulations: Students acquire skills from observation of the development of the simulation state over time.

3.4 Simulation: a promising teaching tool

Simulation is becoming an educational tool in many fields: learning medical practices, learning to drive aircrafts and learning algorithms (Guéraud, Pernin, Cagnat, & Cortés, 1999). De Jong (1991) sets out a number of reasons that promote the use of simulation in the learning process: the attractiveness of simulation for learners, increased motivation, better understanding of phenomena and the ease of taking initiatives and decisions that learners can quickly see its consequences. Practical reasons are also cited (Herzog & Forte, 1994): work on a real system may be too expensive or too long, dangerous to humans, to the environment or equipment, a source of anxiety for the beginner. In a simulation, we can introduce situations of extreme gravity to cause the learner to respond, change the time scale to improve understanding, simplify or tamper with a reality to be better studied.

This does not in any way imply a decrease in the role of real experiments in the laboratory, because the ability to drive the actual experiences such as traditional mathematical skills remains a necessity. The simulation does not replace anything; it is a new educational tool that improves the learning process.

4. Advantages of Collaborative Learning

In Henri and Lundgren's book on collaborative distance learning (Henri & Lundgren-Cayrol, 2001), they spend thirty pages for the definition of this concept. We retain the definition: collaborative learning is every learning activity undertaken by a group of learners with common objectives; each one is a source of information, interaction and motivation. Every learner can benefit other's contributions, the synergy group and trainer facilitating collective and individual learning. It is a method which is in agreement with the proposals of this training, since it is based on the following concepts:

- It gives great flexibility in time and space for teachers in the learning situation;
- It promotes reflection, sharing resources, autonomy, critical thinking and synthesis (Chekour, Al achhab, & Laafou, 2013);
- Cooperation is the fundamental activity for structuring knowledge and solving identified problems;
- The communicative aspect of online learning platforms can support collaborative work by offering high quality communication tools (Mahdi, Chekour, & Laafou, 2014).

In our training, we propose the following steps:

- Step 1- Identify the problem: In this step teachers propose a real problem, which took place in their respective schools for the study in the platform. They identify, in cooperation, the nature of the problem (cognitive, methodological, emotional or otherwise). Collaboratively, they determine what needs to be solved according to their experience and their competence in simulation.
- Step 2- Discussion of the problem: From the study of bibliographic material and previous experience, the problem is discussed in the online platform
- Step 3- Proposition of solution(s): Teachers develop possible solutions via Pspice to the studied problem and share the solutions with their colleagues.

5. Proposed Method

Techno-pedagogical qualification of physics teachers is one of the key factors for effective integration of simulation in the teaching practices of physical sciences. However, our distance learning is not limited to the mastery of technological tools (simulator). It questions the model and the most appropriate approach for optimal integration of simulation in the teaching learning process of electricity concepts.

Our distance learning is based on a comprehensive, effective and smart platform. This platform offers modules to master the software simulation; and it provides a space for physical science teachers to identify students' learning problems in order to seek solutions to these problems through simulation and collaboration with other teachers (see Figure 1). To facilitate access to these resources (for students and other teachers), teachers who create digital resources which remove certain cognitive obstacles, are invited to assign metadata to their products (title, creator, Prerequisites, Public target educational objectives, duration, ...).

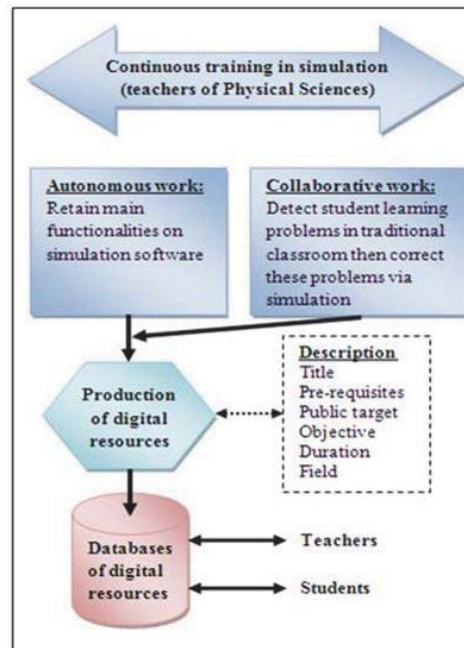


Figure 1. The general scenario of our training

6. Choice of Tools

6.1 Choice of simulator

The simulation is recommended to improve the theoretical understanding of the electricity concepts. Software such as Pspice, Electronics Workbench, Maple, Mathcad, MATLAB and Simulink are used to harmonize the theoretical concepts with the physical phenomena studied. Nevertheless, the quality of Pspice is signaled by many educators and pedagogues (Tuinenga, 1995). As part of this work, we have chosen Pspice for the following reasons:

- Pspice is easy to handle. The free version of Pspice allows its use in high schools (Strollo, 1996);
- Pspice simulation software is the most popular in the industry (Vladimirescu, 1994);
- Pspice is a full software; it allows the simulation of electrical systems, power electronics, digital and analog control electronics (Rusek & Oakley, 2001).

6.2 Choice of platform

There are a variety of e-Learning platforms available on the web. Each has different characteristics that make it flexible to adapt to different learning contexts. The selection of the learning platform Moodle has been made for the following reasons:

- Moodle is a complete platform, efficient, smart and belongs to the latest generation;
- Moodle is an open source platform: We can customize according to the needs of training and learners;
- Moodle is a smart Platform: Trainers can set resource access rules (obligation to read, get some results ...). The trainer can then easily define an educational learning plan;
- Moodle is the most popular platform in the world (Cole & Foster, 2007);

- Moodle is the appropriate platform for teacher’s continuous training (Liu & Wang, 2008).

7. General Structure of Our Training

Our training comprises of a number of modules, which in turn include a number of learning units, each with a specific objective. Each student is invited to take a pre-test in order to evaluate these objectives. For each module objective, we provide a related question. In case of a complete mastery of the module, the system invites the student to move on to the next module, otherwise the student has to take an entry test to verify if he/she has the necessary pre-requisites to start the course. If the student fails the entry test as well, the system will suggest one or several modules to get the student prepared for the course. In the case of a successful entry test, the system will provide a customized learning program for each student based on their pre-test scores, by bringing up modules that correspond to the questions that were answered wrong. Finally, if the student passes the post-test completely, the exit system will move them on to the next module. Otherwise, the learner will be oriented to the learning system based on the results of the last test. In case the acquisition of the Learning Unit (LU) depends on other LUs, the system will include the learning unit in the new learning system (see figure 2).

M: Module LU: Learning Unit SO: Specific objectives
 Q: Question Num_Mod : represents Number of modules of training

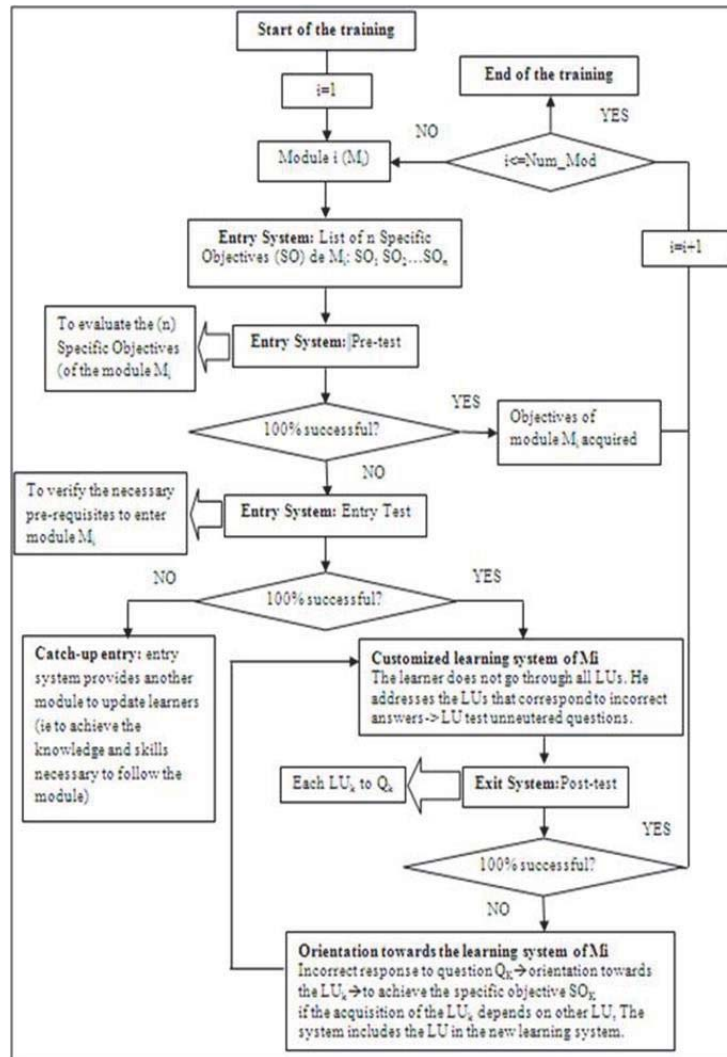


Figure 2. The general structure of our training

8. Model of Educational Resources in UML (Unified Modeling Language)

Our distance learning is composed of a set of modules. Each module concludes in a test and one or more homework projects to submit at pre-determined deadlines. Our model of pedagogical resources uses the UML. The central concept in this model is that of learning unit (LU). A learning unit is either elementary or composite. The basic unit of learning has a unique purpose. The learning unit can be composed of preparatory activities to address new concepts, the presentation of concepts of the course or the application of these concepts through exercises (see figure 3).

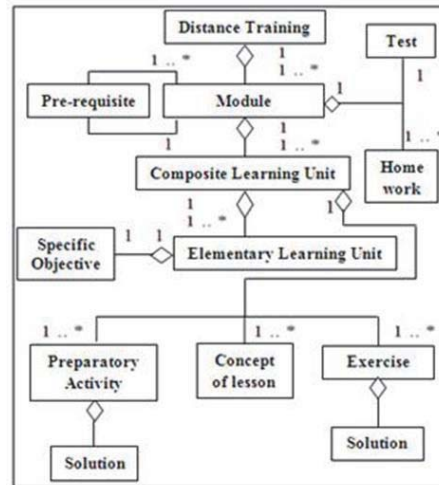


Figure 3. Modeling the training's pedagogical resources

9. Conclusion and Prospects

During the last decade, distance learning has made huge progress especially for continuous training of employees. The use of technology has increased access to educational resources as it encouraged communication in a way that was not possible before. The Ministry of Education is aware of the importance and necessity of continuous training for teachers to develop their professional skills. However, most continuous trainings organized by the ministry are of very short duration (Alj & Benjelloun, 2013) and they pose the problem of teachers' absence during these training. In this situation, distance learning is more than necessary due to its flexibility that eliminates time and space constraints. In this paper, we propose nationwide distance training for physical science teachers in the simulation. The general structure of the training is presented in detail in Section 7. The objective of this training is to provide teachers with a theoretical and practical background of physical sciences in the simulation in order to integrate this technological tool in the teaching of physical concepts. The proposed solution is based on the collaborative learning which is in agreement with the objectives of this training. The choice of the platform Moodle is justified by its clear interface with a simple iconography facilitating access to educational resources. In the case study, we focused on the benefits of Pspice simulator and we presented the model of educational resources that we used in our training.

In a short-term perspective, we consider studies focusing on cultural risks of teachers toward distance training. In the medium term, we plan to study the most appropriate pedagogical scenario to teach simulation by using Pspice to students- teacher.

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