

# MONTESSORI METHOD ADAPTATION FOR TEACHING OF SUBJECTS OF GRADUATE AND POST-GRADUATE PROGRAMMES

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Keywords: Montessori Method, WebCT, EHEA and individual learning.

Abstract: In this paper, the application of the Montessori Method for teaching of subjects in graduate or post-graduate programmes is proposed. The Montessori Method is a pedagogical method used successfully in nurseries and is based on autonomy, independence and initiative for their own student learning. These principles are part of the guidelines of the European Higher Education Area (EHEA). Taking into consideration the aim of the subject Advanced Radar Signal Processing Techniques of the Master Degree on Information and Communication Technologies of the University of Alcalá of Spain, a learning path is proposed based on the main elements of the Montessori Method: the learning environment, didactic areas, learning materials and teacher activities. The final project is a web tool in WebCT platform divided into didactic areas, with material for self-taught students, combined with a teacher who monitors students through the web environment and seminars.

## 1 INTRODUCTION

The European Higher Education Area (EHEA) defines a new model of knowledge transmission (European Ministers, 2009) that requires an adjustment of the current model where prevails the concept of unidirectional transmission, where the student can see his role reduced to a passive one. Students must be presented as protagonists of their learning mission. There are teaching methods widely used in earlier educational stages in which, the emphasis is on student independent learning. Montessori Method (Montessori and Hunt 2009) has been successfully implemented in nursery schools. This method, which was developed by Maria Montessori, engineer, biologist and doctor of medicine, is based on developing the potential for absorption and abilities of children in a specific environment and using scientific observation of a trained teacher.

Despite of Montessori Philosophy is based on the child development theories; this article aims to describe how this methodology could be adapted to a teaching method in graduate and post-graduate programmes. The subject of Advanced Radar Signal Processing Techniques as an example is considered.

This subject belongs to the Master Degree on Information and Communication Technologies of the University of Alcalá of Spain. From the educational point of view, the purposes are preparing students for their professional development and maintaining a broad, advanced knowledge base and stimulating research and innovation.

In addition, post-graduated students usually have limited time resources, since they could be immersed in the labour market. Access into the proposed teaching method should be widened by providing adequate conditions in anytime and anywhere for the development of particular skills and interests of each student. In this paper, an adaptation of the Montessori Philosophy based on an eLearning platform is proposed. The designed learning tool must not limit student action to *observation* but must proceed to *experimentation*. Then, didactic material has to be completely manipulative in order to empower flexible and individual learning.

## 2 ADVANCED RADAR SIGNAL PROCESSING TECHNIQUES IN THE UNIVERSITY OF ALCALA

The subject of Advanced Radar Signal Processing Techniques belongs to programme of Master Degree on Information and Communication Technologies of the University of Alcalá of Spain. This subject is an elective one with 4 ECTS (European Credit Transfer System).

The aim of this subject is that students will be able to raise problems of radar targets detection and classification through hypothesis tests from statistical models of desired targets and interference (clutter and noise). Then, the difficulty of these systems design and the limitations of the solutions used in practice are presented. In this way, the current lines of research attempting to design more robust systems with higher capacities and detectors are described. Understanding the operating principle of HRR (High Range Resolution Radar) and SAR (Synthetic Aperture Radar) is also an important objective in order to define the problems to solve in the processing techniques of these types of signals used nowadays.

Every detail of the subject is easily accessible from the website of the Master Degree: <http://proptic.uah.es/> (Jarabo and Nieto 2009).

## 3 MONTESSORI METHOD

The basic principles of Montessori Pedagogy are based on autonomy, independence, initiative, liberty and self-discipline, which are also underlined by the new educational guidelines.

There are four main blocks in this method: The learning environment, creation of didactic areas, design of learning material and description of teacher activities. An adaptation of each identified block following the Montessori Method basis for Advanced Radar Signal Processing Techniques teaching is described.

### 3.1 Learning Environment

The learning environment must be specifically prepared for students to be academic, comfortable, and to encourage independence by giving them the tools and responsibility of its management. An environment in where all students move usefully, intelligently, and voluntarily, could foster innovation and creativity.

In graduate and post-graduate courses, an environment, that is easily accessible and flexible in time, is proposed in order to allow students free movement to go and come as they like, throughout the entire day in any place. Currently, an Internet platform seems particularly suited to provide these facilities. WebCT (Web Course Tools) or Blackboard Learning System (BLS) (Yaskin and Everhart 2002) platform is the official eLearning platform at the University of Alcalá. The BLS is a powerful instructional tool that is easy-to-use and built to provide a flexible environment to work inside and outside the classroom in ways that make sense to the students learning. A powerful analysis, that permits a monitoring of students academic progress, is also offered to the responsible teachers.

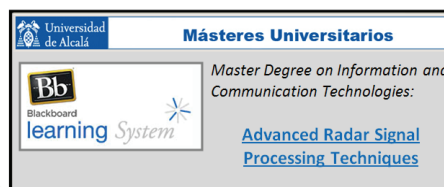


Figure 1: Website of Virtual Course (BLS).

In Figure 1 the Virtual Course of Advanced Radar Signal Processing Techniques is presented. In this virtual space, students have access to all necessary learning material in a simple way. The material is organized into different didactic areas that have hands-on approach to learning the main topics of the corresponding subject, as is suggested in the Montessori Method (Montessori and Hunt 2009). In this environment, students can work at their own pace, encouraging collaboration against competition.

### 3.2 Didactic Areas

These didactic areas, corresponding to the major thematic blocks of the subject, encourage the extension of the knowledge and understanding in parallel and adapted to each student. All proposed areas must be interwoven, not taught in isolation.

In Figure 2, a division into areas of the learning environment is presented attending to the purposes of Advanced Radar Signal Processing Techniques defined in Section 2.

Students are self-taught to decide the order in which they are going to develop the learning mission attending to their skills and concerns. Teachers have the responsibility of observing the students learning, for example, using control tools to ensure that all students have gone through all the defined areas.

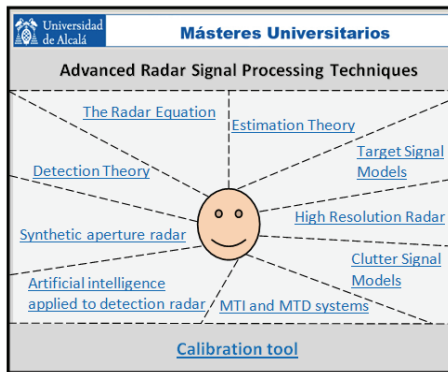


Figure 2: Example of creation of didactic areas in the environment of the corresponding Virtual Course.

### 3.3 Learning Material

The design of specific material, that encourages an independent learning, is a primary task for the success of this teaching method.

In the practical application of the proposed method, didactical material is divided in grades of difficulty (basic, intermediate and advanced) for each area. This is a helpful organization with the aim of facilitating the planning of their learning path without diminishing freedom and responsibility.

Regardless of the grade of difficulty, materials must be familiar and intuitive, but mostly manipulative by students to encourage active learning through experimentation. Research and innovation with this type of teaching method is stimulated.

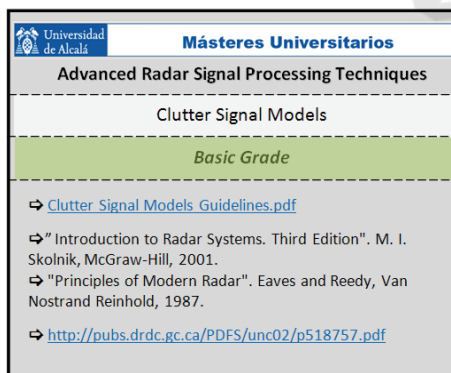


Figure 3: Example of basic grade learning material in the didactic area of Clutter Signal Models.

Material of basic grade (Figure 3) is composed of three types of tools: a learning guide, designed by teachers, which serves as a supporting document to work with the fundamental bibliography; the basic

books of theory; and the main links to URL with information of interest.

The basic knowledge understanding allows students to use materials of intermediate grade where the new acquired concepts have to be applied. In Figure 4, two types of tools are presented. First one is a document developed by the students themselves in order to obtain a final draft of notes. Although, initially is a document prepared by teachers, with graphs and equations of interest, students have to manipulate it with their own words. Moreover, simulation exercises with software tools are proposed as laboratory classes.

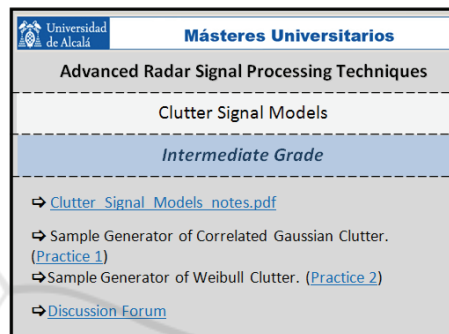


Figure 4: Example of intermediate grade learning material in the didactic area of Clutter Signal Models.

At this level of difficulty, a discussion forum is very interesting because the student-student and student-teacher dialogue is facilitated.

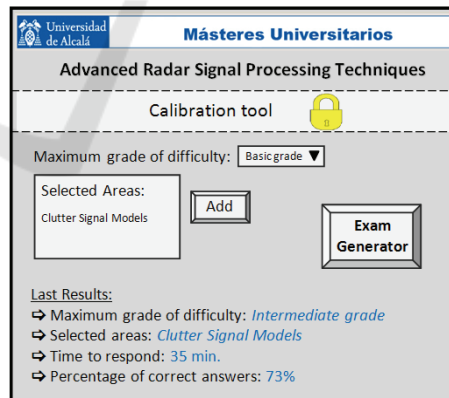


Figure 5: Example of calibration tool.

In these two grades of difficulty, a calibration tool, or error control, is proposed in order to allow students assessing their knowledge. Following the Montessori Philosophy, the proposed tool (Figure 6) is based on an adaptable and flexible test developed in the BLS. Students can choose each time, for the exam, the didactic areas and the level of difficulty.

With this self-assessment, students learn to correct their own mistakes instead of relying on a teacher to give them the correct answer.

Finally, at the advanced grade (Figure 6), an updated view of the subject under study is presented. The learning materials are innovative papers in international and national scientific journals on lines that are fostering greater professional and research activity. The final purpose is the development of particular skills and interests of each student individually and the possibility of a lifelong learning.


 <b>Másteres Universitarios</b>	
<b>Advanced Radar Signal Processing Techniques</b>	
Clutter Signal Models	
<b>Advanced Grade</b>	
⇒	Computer Generation of Non-Gaussian Radar Clutter, M. Rangaswamy, D. Weiner and A. Öztürk. IEEE Trans. on Aerospace and Electronic Systems, Vol. 31, No. 1, pp. 106-115, January 1995. ( <a href="#">Full text</a> )
⇒	Radar detection of correlated targets in clutter, A. Farina, A. Russo. IEEE Trans. on Aerospace and Electronic Systems, Vol. AES-22, No. 5, pp. 513-532, September 1986. ( <a href="#">Full text</a> )
⇒	Advanced models of targets, disturbances and related radar signal processors, A. Farina, A. Russo. Proc. Of the International Radar Conference, Washington D.C., pp. 151-158, Mayo 1985. ( <a href="#">Full text</a> )

Figure 6: Example of advanced grade learning material in the didactic area of Clutter Signal Models.

### 3.4 Teacher Activities

Self-learning is as important as a scientific observation by the teacher (Montessori and Hunt 2009). Students monitoring allows teacher to know what they need to improve individually.

Design and creation of learning material to all three grades of difficulties, as well as the adaptive tool for self-assessment is a preliminary work of teacher.

During the class period, teacher plays an active role in monitoring the interest and participation of students in each area. Student-teacher dialogue is developed through the discussion forums or seminars. For example, the seminars could be planned with a brief speech from each student about the done activities in each area with the corresponding grade of difficulty, discussing about both the acquired knowledge as emerged doubts in the learning process. Thus, public speaking is trained and personal growth is encouraged through social relationships with peers.

## 4 CONCLUSIONS

Taking into consideration the new learning paths of European Higher Education Area (EHEA), a teaching method used successfully in other stages of education is considered.

In this paper, the adaptation of the Montessori Method for teaching of subjects in graduate or post-graduate programmes is proposed. The Montessori Pedagogical Principles are based on the cognitive structures and social development.

A learning environment, easily accessible through the WebCT platform of eLearning, is suggested. This environment is divided into didactic areas where students can move freely and independently to study each of them. The purposes are to create individual learning plans and to encourage an active learning. Inside each area, there are learning materials classified by grade of difficulty.

The designed materials are mainly characterized by allowing students their self-development through experimentation. An adaptable and flexible calibration tool is proposed as control error in order to encourage that students learn of their own mistakes.

Teacher must observe monitoring of the students through discussion forums and seminars to ensure their progress in all defined areas.

## ACKNOWLEDGEMENTS

This work has been supported by University of Alcalá of Spain, under Project UAH/EV299.

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