

**RSNA R&E Foundation Education Scholar Grant  
Education Scholar Grant Application**

**Salvador Pedraza, MD  
University of Girona**

NOTE: Personal information for the applicant and other investigators has been removed from this sample application.

**Title: DEVELOPING A COMPUTER GAME FOR PROBLEM BASED-LEARNING (PBL) OF RADIOLOGY FOR UNDERGRADUATE MEDICAL EDUCATION (MEDGAME)**

**Abstract:**

There is a need to improve the learning of radiology in medical schools. Problem-based learning (PBL) is a well-known educational strategy based on self-directed learning and team work. PBL has proven benefits in different fields of medical education. However, PBL has yet to be applied to many aspects of radiological education. We hypothesize that the introduction of a radiological computer game in PBL will increase medical students' motivation and thus improve their learning of radiology. The main aim is to develop a radiological computer game, MEDGAME, to help medical students learn the principles of image interpretation and to apply appropriate criteria when requesting radiological tests. We will use the latest interactive technologies to create MEDGAME. MEDGAME will be developed in two phases. During the initial phase, a computer game simulating common clinical problems in the emergency room will be developed. A case-based tutorial and set of challenges will be incorporated into MEDGAME. During the second phase, MEDGAME will be integrated into PBL sessions and practical seminars for learning radiology in our medical school. The MEDGAME initiative will be an opportunity to assess the effectiveness of a novel interactive resource for radiology learning. The MEDGAME project may serve to establish collaborative knowledge that would potentially benefit other academic disciplines.

**Percent of Time Dedicated to this Project:**

10%	Project ( 2 years).
40 %	Radiological Clinical Work
20%.	Management.
20%	Teaching.
10%	Research

**Priority Statement:**

Salvador Pedraza has been involved in teaching radiology for the last 20 years and has several years' experience in the implementation of PBL in the School of Medicine of the University of Girona. He collaborated in the recently published White Paper on Undergraduate Radiology Education. He is a member of the European Board of Neuroradiology. He is the Director of the Diagnostic Imaging Institute (IDI) at the Dr Josep Trueta University Hospital of Girona. He is a well-recognized leader in clinical radiology, specifically in the field of neuroradiology. He is an active researcher and has experience as principal investigator in several funded research projects. He has authored more than 100 publications and has presented more than 300 poster and oral communication. Salvador Pedraza has a keen interest in the development of educational tools for the learning of radiology in medical education. PBL is the main teaching method at the School of Medicine of the University of Girona. He has collaborated actively in the application of PBL to radiology teaching and considers computer games logical complements to PBL because they make it possible to simulate clinical problems, increasing students' motivation and long-term retention of knowledge and skills. Salvador Pedraza will act as the principal investigator of the project, coordinating the different activities. He will be responsible for elaborating the tutorials and the computer game, as well as for integrating it with the other educational activities used for the learning of radiology (PBL sessions and practical seminars).

**Budget:** *(Budget details have been removed from this sample)*

Project Timeframe: 7/1/2012 - 6/30/2014

Total Project Budget: \$150,000

Amount Requested: \$150,000

## Complete Budget Justification

### A. Personnel

Institution: Support of the Medical Education Unit to the Integration of Medgame:	\$15,000
Informatics support: (Informatics staff to solve problems of Medgame users)	\$ 5,000
Administrative support:	\$ 2,000
Web page and informatics: (Design and maintenance of the Medgame webpage)	\$ 3,000
Creation of Computer game: (Salary cost of two engineers that will create MEDGAME)	\$52,000
Translation to English:	\$ 3,000
Integration, coordination of PBL with MEDGAME related to the creation of tutorial:	\$70,000

### B. Supplies

### C. Other (none)

## Other Investigators:

### **Joan C Vilanova**

**Role:** Joan C Vilanova is the Coordinator of Radiology Education at the Medical School of the University of Girona. He is the director of the largest magnetic resonance imaging unit in Girona and works in the radiology department of a large hospital associated to the University, the Hospital Santa Caterina of Girona. He is a recognized leader in clinical radiology particularly in the fields of musculoskeletal, abdominal, pelvic, and breast imaging. He is an experienced researcher and he will collaborate in the elaboration of the tutorials and challenges in MEDGAME as well as in the integration of MEDGAME into PBL sessions and radiology seminars.

### **Enric Marti**

**Role:** Enric Marti is an associate professor of the Computer Science Department at the Autonomous University of Barcelona (UAB); he specializes in computer graphics and vision. He is the director of a master's program in the development of computer games at the UAB. He is a recognized leader in the area of computer graphics, specifically in the field of games elaboration. He is the coordinator of the PBL group at the UAB. He is an experienced researcher and the author of several publications about medical imaging, computer graphics, and PBL in computer science. He will oversee the elaboration of the computer game MEDGAME as a game designer and senior programmer.

### **Carles Muñoz**

**Role:** Carles Muñoz's area of expertise is radioprotection. He is an associate professor at the Medical School of the University of Girona. He heads the Medical Physics and Radiation Protection Department at the Dr Josep Trueta University Hospital. He is also the Director of the corporate program of Medical Physics and Radiation Protection of the Catalan Institute of Oncology (Barcelona, Girona, and Badalona). He will collaborate in the elaboration of radioprotection-related questions in the tutorial and challenges in MEDGAME as well as in the integration of MEDGAME into PBL sessions and the practical radiology seminars.

### **Elda Balliu**

**Role:** Elda Balliu is a specialist in musculoskeletal radiology and an associate professor of radiology at the Medical School of the University of Girona. She has done research about the validation of new magnetic resonance sequences in musculoskeletal pathology, leading to several publications. She will collaborate in the elaboration of the tutorial and challenges of MEDGAME as well as in the integration of MEDGAME into the PBL sessions and radiology seminars.

### **Jordi Arnal**

**Role:** Jordi Arnal is a computer engineer at the Polytechnic University in Barcelona (Barcelona Tech). He has worked in different computer game companies as a game designer and senior programmer. He is a professor in the UAB's master's program in the development of computer games. He is an experienced researcher and he has collaborated extensively with medical investigators. He will develop the radiological computer game MEDGAME as a game designer and senior programmer.

### **Pere Nolla**

**Role:** Pere Nolla has a degree in audiovisual communications and is currently doing a PhD in psychology. He has worked as a graphic designer in different media and computer game companies. His research area is the study of the psychology of computer games. He is a professor in the UAB's master's program in the development of computer games. He will develop the radiological computer game MEDGAME as a game designer and senior art designer.

## Detailed Education Plan: (See Next Page)

## **A. Detailed Education Program:**

### **Introduction. Rationale and Purpose:**

**Problem-based learning (PBL).** Several publications indicate the need to improve the learning of radiology in medical school (1,2,3). PBL is a recognized educational strategy that has been implemented for more than 40 years in health sciences education (4, 5). In PBL, a problematic situation, case, or scenario is the starting point for a discussion in a small group of students (Figure 1). PBL promotes student autonomy and the development of self-directed learning skills, which are essential in the process of continuing education of the professional. PBL has been successfully implemented in the learning of radiology and some of its associated disciplines (6-10). In PBL, students develop their own objectives within the context of their program's learning objectives with the guidance of a faculty facilitator without previous formal lectures or classes (4). PBL has several advantages (5-7):

- a) PBL students learn as well as their traditional program peers and develop excellent group and cognitive analytical skills.
- b) PBL students have more motivation and commitment, as well as more cooperative behavior.
- c) PBL requires extensive use of learning resources (books, journals, and people), providing students with the attitudes and skills needed for continuing medical education throughout their careers as physicians.
- d) Both students and teachers report high levels of satisfaction with PBL.
- e) PBL encourages teamwork and helps students develop teamwork skills that will be useful in professional life.
- f) PBL is enjoyable for both students and faculty members.

Although PBL has been implemented in the learning of radiology, specific computer educational tools need to be developed.

**Computer games.** Computer games are an important entertainment industry; however, computer games can be more than just fun. In the last 25 years research in several fields (psychology, pedagogy, etc.) have found many benefits from computer games (12-15):

- a) Computer games immerse students in a simulated environment where they can explore and test their professional capabilities.
- b) Computer games provide students with the opportunity to assume a professional role in the first person in an immersive simulated environment.
- c) Computer games can quantify students' actions and allow them to evaluate their skills and to know whether their skills have improved.
- d) Students are very familiar with the technology and interactivity of computer games.
- e) Computer games allow each student to adjust the rate of his or her personal learning process.
- f) Computer games work with a progressive challenge-reward structure that highly motivates students and improves their self-esteem.

g) Computer games are highly suitable for teamwork interaction. They can facilitate the development of cooperative behavior.

h) Computer games especially help develop cognitive abilities, including perception, attention, memory, focus, and rapid decision making.

i) Computer games appear to engage and amuse people of diverse ages and both sexes.

### **Objectives:**

We hypothesize that the development of a radiological computer game will improve the effectiveness of PBL applied to radiology and its associated disciplines.

The primary objective of this project is to develop and validate MEDGAME. The secondary objective is to develop a learning tool about the principles of image interpretation and appropriate requests for radiological tests.

In the future, we plan to extend the content of this learning tool to cover other material, such as a) Radiological neuroanatomy of the brain, head and neck, and spine, b) Optimization of radiation dosage during imaging examinations, and c) Physical principles underlying MRI.

### **Student Population:**

The learner group will be the 150 second-year medical students at the Medical School of the University of Girona during the 2012-2013 academic year.

### **Previous Experience:**

-Salvador Pedraza has experience in applying PBL methodology to teaching radiology and anatomy and in the coordination of research projects. Joan C Vilanova, Carles Muñoz, and Elda Balliu have experience in the teaching radiology with PBL.

-Enric Marti has experience in the development of computer games and in the coordination of research projects. Jordi Arnal and Pere Nolla have experience in the design, creation, and production of commercial games.

### **Project Plan**

#### **-Description of work, and role of participants**

MEDGAME will be developed in a Windows platform with Visual-basic as a tool to design the characters. The program 3D Studio Max will be used to create the 3D environment. The different cases and situations will be elaborated in XML to avoid interferences from new changes to the program. The application will be scalable to allow further developments of new modules. MEDGAME and the application will be available on the webpage of the Medical School of the University of Girona.

MEDGAME will be developed in two phases. In the initial phase a computer game simulating common clinical problems in the emergency room will be developed. A tutorial of cases and a set of challenges will be incorporated into the game (tasks 1, 2, 3). In the second phase, MEDGAME will be integrated into PBL sessions and practical seminars at our medical school (tasks 4, 5, 6).

#### **Task 1: Creation of the game.**

The game will simulate the clinical activity in an emergency room. A user-friendly interface will enable students to interact with modern-looking characters such as emergency physicians, surgeons on call, radiologists on call, and radiology technicians.

These characters will collaborate with the student in attending the patients, soliciting students' opinions and decisions at each step.

At the beginning of the game, students will first choose an avatar (male student or female student). Next, the student will enter the Medical Room, where the medical staff will inform them about the patient. The emergency physician will inform the student about the patient's clinical history and will ask the student questions about the next steps in the diagnostic workup. The student will have to decide which diagnostic tests to order (plain-film X-rays, sonography, computed tomography, magnetic resonance, angiography) and will have to demonstrate that they know the contraindications for each test. When relevant to the procedure, the student will also have to know the indications and contraindications for contrast administration.

There will be different scenarios depending on the options the student chooses.

Three patients will be in the student's care. The first patient will be a pregnant young woman involved in a motorcycle accident. She will have pelvic fractures with acute bleeding. The second patient will be an elderly man with paraplegia due to spinal cord compression and a previous history of prostate cancer. The third patient will be a five-year-old boy with pneumonia.

The student will interact with these patients and will face questions and challenges like those encountered in real life in an emergency room. The student will choose options and will make decisions that affect the status of the patient. The decision tree will have several branches and the student will know if a specific decision carries a risk of adverse events for the patient. In these cases, the student will be able to return to the beginning of the sequence of decisions for the better management of the patient. Different tutorials will be available to allow students to review the main teaching points and the different scenarios, and students will have access to references to obtain more information.

MEDGAME is a first-person game in 3D. The student is the first-person character. The interface will be similar to the most common "first-person shooter" computer games, with messages, sounds, and objects in motion.

The interface of the game will be friendly and easy for students to manage. Students will have tools to enable them to do a basic analysis of the images (measure, zoom, window, compare) and the format of the tutorial associated to each patient. Self-assessment quizzes will be included to provide prompt feedback. It will be possible to capture a sequence of a simulation in video to show correct or incorrect actions and decisions during the simulations. This feature will be useful when discussing students' experiences with the other members in PBL activities.

**Task 2: Elaborate the set of questions and information to be included for the preparation of the game.** We will elaborate a set of 50 questions about the main learning points that the student should know before the beginning of the game. The tutorial will focus on the contraindications of the different imaging techniques and in the correct interpretations of a radiological image. This tutorial will include normal and pathological images from different modalities such as plain-film X-ray, sonography, computed tomography, magnetic resonance, and scintigraphy.

**Task 3. Elaboration of the question and information to be included in the game as challenges.** We will elaborate the clinical information of each patient in the game. We will include information about age, sex, symptoms, reason for the study, examination technique, main results, presence of artifacts, anatomical variants of normal findings, conclusion of the radiological reports, and implications for the management of the patient. Approximately seven challenge scenarios will be created for each patient; thus, the game will have three patients and 21 challenges.

**Task 4: Integration of the MEDGAME in the teaching process with PBL and practical seminars.** The students will follow the schedule of PBL sessions and practical seminars of the Radiology module of the second year of the Medical School of

the University of Girona. In addition, they will have the MEDGAME tutorial and computer game to facilitate learning. The investigators will help students integrate the tutorials and MEDGAME into PBL and practical seminars.

**Task 5: Assessment of the experience about the challenges of the MEDGAME.**

The investigators will conduct a survey about the students' opinion of the usefulness of MEDGAME. Furthermore, medical students' final level of competence in the two areas (correct analysis of radiological images and appropriate indication and requesting of radiological examinations) will be assessed. The investigators will compare the results of learning in these two areas between a group of students without MEDGAME and with MEDGAME integrated with PBL (the students of previous years 2009-2010, 2010-2011, and 2011-2012).

**Task 6: Diffusion of the project MEDGAME.** The results of the project will be presented at congresses and will be submitted for publication to relevant journals in related fields. The game will be accessible from the Medical School's webpage.

**Time Schedule:**

The project will last 24 months, from March 2012 to March 2014.

*a) March 2012-September 2012.*

-Development of repositories and challenges of MEDGAME.

*b) September-2012- December 2012*

-Application of the repository in each work package.

*c) January 2013-Septembre 2013.*

-Application of the challenges of the computer game MEDGAME in combination with PBL and practical seminars.

*d) October 2013- March 2014*

-- The students will be surveyed about their experience with the database of 50 cases, tutorial, and interface and the results will be evaluated. Mistakes will be corrected, problems will be solved, images with problems will be erased, and new images will be integrated in the repository

-Final validation of repositories and challenges of MEDGAME

*e) January-March 2014*

-Online publication of the English version of MEDGAME.

**Outcomes**

-This project will make it possible to examine the degree of relevance of a specific computer game dedicated to PBL radiology education. The educational program and material that will be developed through this project is the computer radiological game MEDGAME with different repositories of cases and challenges for PBL radiology education.

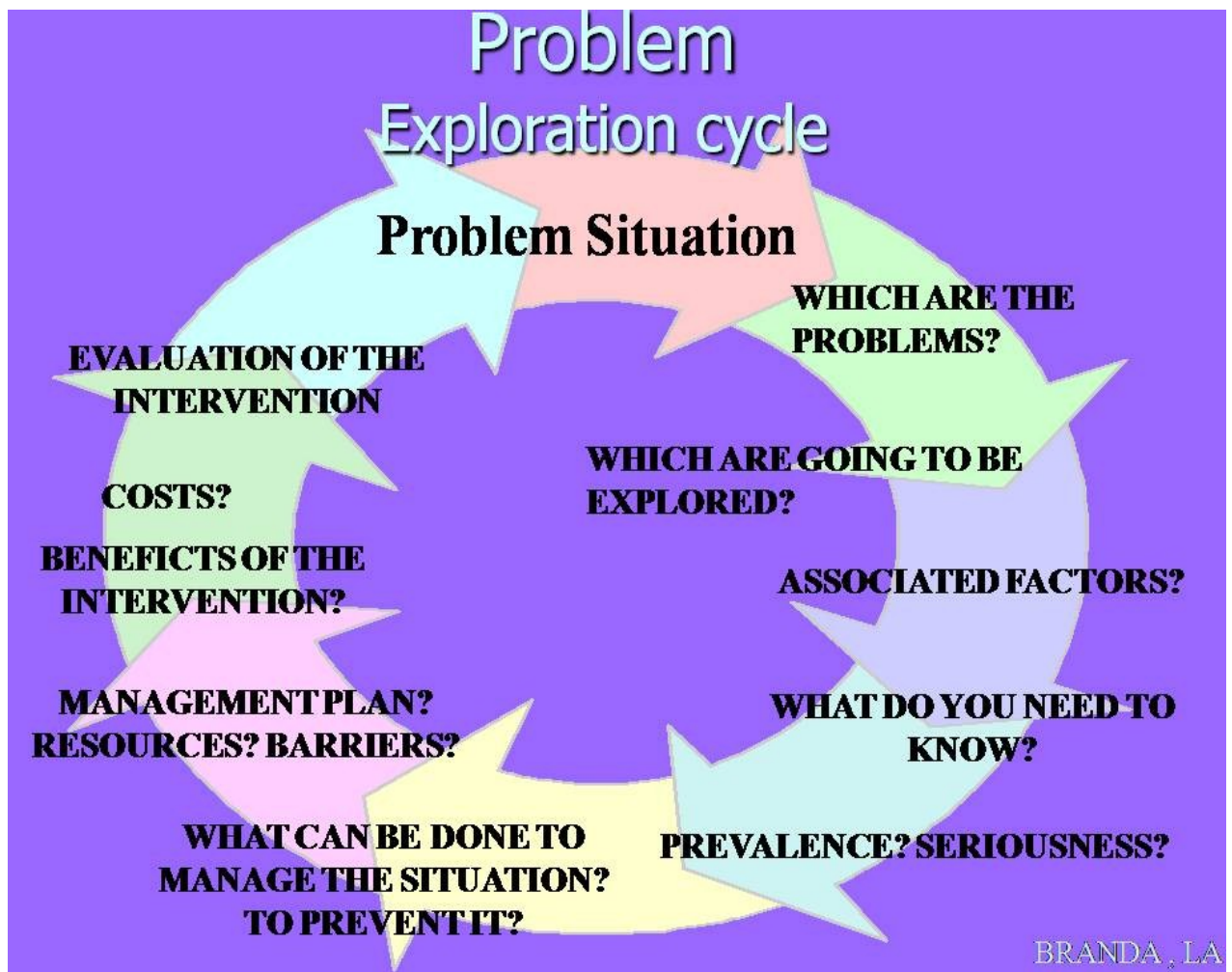
-The investigators intend to present and publish the results of this study.

### Evaluation:

Each student trained with MEDGAME will complete a written examination about the knowledge and skills acquired in the Educational program. We will try to demonstrate statistical differences between the results of this group of 100 students trained with MEDGAME and PBL with respect to the results of the group of 240 previous students trained only with PBL.

### **Figures**

**Figure 1. PBL Method ( Problem Exploration Cycle)**



### References

- 1-Branstetter BF, Humphrey AL, Schumann JB. The long-term impact of preclinical education on medical students 'opinions about radiology. Acad Radiol 2008;15:1331-1339.
- 2-Harding J, McCoubrie P. Competency-based training versus traditional experience in radiology; how best to educate the radiologist of the future? Clin Radiol 2009;64:569-573.

- 3-Ding A, Mueller PR. The breadth of teaching commitment in radiology departments: A national survey. *J Am Coll Radiol* 2010;7:290-293.
- 4-Branda LA, El aprendizaje basado en problemas. De herejía artificial a *res popularis*. *Educ Med* 2009; 12(1) 11-23.
- 5-Koh GCH, Khoo HE, Wong ML, Koh D. The effects of problem-based learning during medical school on physician competency: a systematic review. *CMAJ* 2008; 178: 34-41.
- 6-Chen SK, Chang HF, Chiang CP. Group learning factors in a problem-based course in oral radiology. *Dentomaxillofac Radiol*. 2001 Mar;30(2):84-7.
- 7-Bui-Mansfield LT, Chew FS. Radiologists as clinical tutors in a problem-based medical school curriculum. *Acad Radiol* 2001;8:657e63.
- 8-Thurley P, Dennick R. Problem-based learning and radiology. *Clin Radiol* (2008) 63, 623e628.
- 9-Subramaniam RM. Problem-based learning: concept, theories, effectiveness and application to radiology teaching. *Australas Radiol*. 2006 Aug;50(4):339-41.
- 10-Miller A, Rudland J, Hurrell M, Ali Anthony. Rad-Path: Integrated anatomical pathology and radiology undergraduate tutorials. *Pathology* 200;41(5):460-466.
- 11-Marker DR, Bansal A, Juluru K, Magid D. Developing a radiology-based teaching approach for gross anatomy in the digital era. *Acad Radiol* 2010; 17:1057-1065.
- 12- Méndez, A. *et al.* (2002). Videojuegos y educación: una revisión crítica de la investigación y la reflexión sobre la materia. Videojuegos y educación. Serie Informes. Ministerio de Educación y Ciencia. <http://ares.cnice.mec.es/informes/02/documentos/indice.htm> (Accessed: 02-01-2012)
- 13-Johnson, WL, Wu, S, Assessing Aptitude for Learning with a Serious Game for Foreign Language and Culture . *Lecture Notes in Computer Science*, 2008, Volume 5091/2008, 520-529. <http://www.springerlink.com/content/b41837422t679m15/> . (Accessed: 02-01-2012)
- 14- Johnson, WL, Vilhjalmsson, H, Marsella, S. Serious Games for Language Learning: How Much Game, How Much AI? Proceedings of the 2005 conference on Artificial Intelligence in Education: Supporting Learning through Intelligent and Socially Informed Technology.  
<http://dl.acm.org/citation.cfm?id=1562569>. (Accessed: 02-01-2012)
- 15-Robinson, E. The Top 10 Weird Children Of Video Games and Neuroscience.  
[http://www.gamasutra.com/view/feature/6466/the\\_top\\_10\\_weird\\_children\\_of\\_video\\_.php](http://www.gamasutra.com/view/feature/6466/the_top_10_weird_children_of_video_.php)  
(Accessed: 02-01-2012)