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A new e-learning platform for radiology education (RadEd)

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ABSTRACT

One of the key elements of e-learning platforms is the content provided to the students. Content creation is a time demanding task that requires teachers to prepare material taking into account that it will be accessed on-line. Moreover, the teacher is restricted by the functionalities provided by the e-learning platforms. In contexts such as radiology where images have a key role, the required functionalities are still more specific and difficult to be provided by these platforms. Our purpose is to create a framework to make teacher's tasks easier, specially when he has to deal with contents where images have a main role. In this paper, we present RadEd, a new web-based teaching framework that integrates a smart editor to create case-based exercises that support image interaction such as changing the window width and the grey scale used to render the image, taking measurements on the image, attaching labels to images and selecting parts of the images, amongst others. It also provides functionalities to prepare courses with different topics, exercises and theory material, and also functionalities to control students' work. Different experts have used RadEd and all of them have considered it a very useful and valuable tool to prepare courses where radiological images are the main component. RadEd provides teachers functionalities to prepare more realistic cases and students the ability to make a more specific diagnosis.

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1. Introduction

E-learning tools have become essential elements of teaching and learning methodologies. They provide functionalities that allow educators to improve communication and interaction between students, group development, personalised attention and access to material, amongst others. In addition, current technologies allow the creation of educational material that combines images, videos, text and sounds [1–4]. These materials can be interactively accessed by students providing feedback according to their actions. In this context, the

student-centred methods where students have a more active role can benefit from e-learning tools and the large variety of activities that can be prepared. However, e-learning success depends not only on the functionalities provided by these new technologies but also on the provided contents. It is necessary that teachers prepare proper material for theory and practice to obtain the desired e-learning results. Content creation is a time demanding task that requires an extra effort by the teachers. We will focus our attention on content creation tools for topics that require a highly visual content such as radiology. Radiological images are essential not only for diagnosis but also for teaching and research. In radiology education, which

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occurs at the undergraduate, graduate, and postgraduate levels, students are exposed to a large number of radiological images to acquire and improve diagnosing skills [5,6]. In this context, the use of e-learning tools started twenty years ago [7–10] and it is an area of continuous development since it improves students' problem-solving ability [11–14]. Currently, throughout the European medical institutions, e-learning is involved in 70% of the time in radiology teaching [15]. For a review of e-learning work in radiology education see [16–18].

One of the key components of radiology education are the clinical cases used by teachers to introduce concepts and given to students to practice. Generally, these cases include radiological images, a description, and optionally questions for student assessment or self-study [19–27]. The case preparation requires collecting medical images from a PACS, extracting the informative tag attributes and denomination of the collected DICOM images, and presenting DICOM images in the proper format. The cases can be selected from personal collections or from common repositories. Focusing on the latter, there are websites created by official institutions such as the Radiological Society of North America (RSNA) or the European Society of Radiology (ESR) [28] which provide imaging databases and hypermedia documents with clinical cases. There are other websites such as *AuntMinnie* which provides radiologists and other professionals in the medical imaging industry a space to share and propose radiology cases, while offering some other functionalities such as a forum to communicate between the users related to the field of radiology [29]. Finally, there are more advanced websites that include functionalities for

content creation. Some of them are presented in the following. *MyPACS.net* is a web-based authoring tool where radiologists can build on-line teaching file repositories to share and archive collections of images for using in slides or publications [24]. The *E-Learning in Radiology* project (ELERA) is a database of image-based teaching information with functionalities to create tests [30]. *COMPARE Radiology* is a web-based authoring software that provides anatomy cases with different levels of difficulty to students [25]. The *Medical Imaging Resource Center* (MIRC) project provides tools to share images and information for education, research, and clinical practice. It has an authoring tool to create radiology teaching files and other electronic documents in flexible formats with a common underlying structure [31]. *Radiology ExamWeb* is an application for teachers to create test exercises following a standardised format. Students can answer the tests obtaining feedback immediately [32]. The *Key Image and Case Log Application* (KICLA) is a software that works together with a PACS and allows users to store key images, image series and cine clips, in public or private folders that can be shared with other users [33]. *RadStax*, proposed by Colucci et al., is a web-based programme with an image viewer that allows the creation of labels on regions of interest of the images and also the introduction of information related to these labels. It also supports multiplanar visualisation and search functionalities [34]. In their work, they also defined the ideal resource for radiology teaching as the one that provides eight main features: (i) a fast and intuitive way to create labels for all anatomy of interest; (ii) the incorporation of basic information about each labelled region of interest; (iii)

Table 1 – Comparison of main web-based systems for radiology education including RadEd in the last column.

	MyPACS [24]	COMPARE [25]	ELERA [30]	ExamWeb [32]	KICLA [33]	RadStax [34]	RadEd
Content							
Focus of interest	Radiology	Radiology	Radiology	Radiology	Radiology	Anatomy	Radiology
Purpose	Theory	Theory	Practice	Practice	Theory	Theory	Practice
Cases search	Yes	No	Yes	Yes	Yes	No	Yes
External resources	No	No	No	No	No	No	Yes
External links	No	Yes	Yes	No	No	No	Yes
Learning functionalities							
Presentation-based	Yes	No	No	No	No	Yes	Yes
Types of exercises	Test	Guessing	Test	Test	No	Guessing	Test, location
Helping text for exercises	No	Yes	Yes	Yes	–	No	Yes
Exercise customisation	Medium	Low	Medium	Medium-high	–	Low	High
Assessment strategies	No	No	No	Yes	–	No	Yes
Image interaction							
Image importance	High	Medium-high	Medium	Low-medium	Medium	High	High
2D/3D/MPR	2D	2D	2D	2D	2D	2D & MPR	2D
Labels creation	Yes	No	No	No	No	Yes	Yes
Annotations creation	Yes	Yes	No	No	No	No	Yes
Basic operations (zoom, pan...)	Yes	Zoom	No	No	No	MPR Slices	Yes
General features							
Cross-browser	High	Low	High	Medium	Medium-high	Medium	High
Software dependency	Partially	No	Partially	No	Yes	No	No
Requires installation	No	No	No	No	Yes	No	No
Collaborative learning	Medium-high	Low	Low	Medium-high	High	Low	Low
User-friendly interface	Medium	Low-medium	Medium	Medium-high	Medium	High	High
Software knowledge	Medium	Low-medium	Low	Low	Low	Low	Low
Multilanguage	No	No	No	No	No	No	Yes

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