Using Digital Medical Collections to Support Radiology Training in E-learning Platforms

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Abstract. This work is focused on using the huge amount of medical cases available in medical digital collections to support specific radiology training courses, particularly addressed to medical residents. Such support is based on retrieving information items from these extant digital collections and generating instructional resources that can be deployed in the resident training context. The key element for this information management is a tool called *Clavy*, which retrieves pieces of content in medical collections and allows hospital tutors to generate educational resources easily under standard specifications and work with them in the most popular e-learning platforms. An example of a radiology course was implemented in *Moodle* to demonstrate the *Clavy* approach to the generation of training resources and their use in e-Learning platforms.

Keywords: Medical knowledge · Learning objects · E-learning platforms

1 Introduction

Medical knowledge has been growing over the last years in an exponential way. Such growth is particularly significant in the area of radiology, where multiple medical digital collections related to radiology topics have been developed. The current work is focused on using the huge amount of medical cases available in these collections, to support specific training courses, particularly addressed to medical residents who combine the practice of medicine and instruction. To this aim, we have developed an experimental tool called *Clavy* [2, 3], which can help to organize these repositories and contribute to improving the knowledge gathered by radiologists during their residency period in hospitals. A group of physicians at the *la Fe* hospital (Valencia, Spain) has recently started to practice with a set of medical case examples in the radiology area to test their training potential and the suitability of information management tools for processing them. Assessment results from the process promoted by *Clavy* involving these physicians are very positive.

The remainder of the work is structured as follows. Section 2 introduces the *Clavy* approach. Section 3 exemplifies this approach. Finally, some conclusions and further work are drawn in Sect. 4.

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2 The *Clavy* Approach

Clavy supports a three-step workflow:

- In the first step, instructors discover and import digital resources from different sources with a high educational value suitable to be transformed into learning objects. For this purpose, *Clavy* enables the aggregation of the content of multiple collections using *plug-ins*. In the case of simple medical collections (e.g., unstructured sets of DICOM images) it can be possible to use a general-purpose *plug-in* to perform the importation (e.g., in this case, a *plug-in* able to extract the information from DICOM records). However, more complex collections (e.g., *MedPix* or *EuroRad*) will already exhibit a collection-specific structure that must be adequately preserved by the importation process. In this case, the most typical situation is to provide a collection-specific *plug-in* able to connect to the external source in order to ingest relevant learning objects together with all the associated information.
- In the second step, instructors can curate all the information imported, ensuring a coherent and unified structure and reorganizing the repository to meet the specific needs of the target users (medical residents, in our case).
- In the third step, objects can be exported in standard e-learning formats like IMS-CP, SCORM or IMS Common Cartridge to be published in suitable learning management systems or in other e-learning platforms. For this purpose, *Clavy* provides a second kind of *plug-in* to export the complete repository, or a part of it, to third-party platforms.

3 Applying the *Clavy* Approach to *MedPix*

In order to exemplify the different aspects of the *Clavy* process, we will outline how it was used on the aforementioned *MedPix* medical collection on clinical cases [1]:

- Importation was carried out using a collection-specific *plug-in*. This *plug-in* lets residents' instructors recover *clinical cases* as learning objects. In *MedPix, clinical cases* (comprising clinical images and additional descriptive information) cover different *clinical topics*, since both types of elements are cross-referenced. Therefore, once the instructor indicates the clinical cases to ingest the following steps are performed: (i) the *plug-in* uses the *MedPix* REST API to recover the URLs in *MedPix* for these clinical cases; (ii) in turn, each case can be recovered by using the REST API again; (iii) then, by scraping each case, the *plug-in* is able to discover the set of related topics; (iv) the actual information for the topics can be retrieved by using the REST API a third time; (v) topics are in turn scraped to retrieve additional related cases, which are then ingested and analyzed until all the relevant information has been retrieved; and (vi) once all the relevant information is ingested, the *plug-in* makes all this information persistent as a *Clavy* repository.
- Once the learning objects were imported into *Clavy*, instructors of residents curated these objects by using a *schema* editor and a *learning object* editor. In particular, the *schema* editor was very useful for adapting the initial organization produced by the

importation *plug-in* to specific educational settings. Indeed, the initial *MedPix* schema contained 72 attributes, many of which are not excessively interesting from an educational point of view. After editing it, these attributes were reduced to 28, the most useful from an educational point of view, plus some oriented to enhancing structure (Fig. 1a).

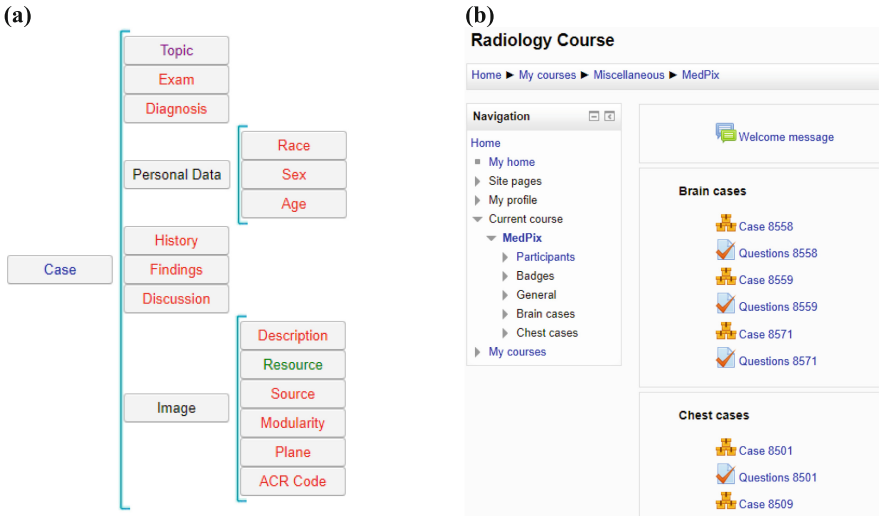

Fig. 1. (a) Excerpt of the reconfigured *Clavy* schema for learning objects imported from *MedPix*; (b) snapshot of the sample *MedPix*-based course deployed on *Moodle*.

– The resulting learning objects, associated to *MedPix* medical cases, were used to implement a sample course on *Moodle*. For this purpose, these learning objects were exported as IMS Content Packages using a suitable *Clavy* exportation *plug-in*. The course was organized using a simple structure (Fig. 1b): (i) an *Introduction* forum that explained its main features, inviting participants to ask questions about the course objectives; and (ii) a main corpus of *MedPix* medical cases with their structured description and attached MCQs (Multiple Choice Questions) to be answered by volunteer residents.

The course finally implemented allowed us to assess the approach promoted in this work in two different dimensions:

– On one hand, the course let us assess the extent to which the approach can suit the needs of instructors (the staff in charge of tutoring residents). For this purpose, we actively involved instructors in the design of the course. They found the simple instructional structure proposed, based on the intercalation of clinical cases and related MCQs, adequate, and helped to select the corresponding items.
– On the other hand, the course was used to explore the access to the instructional resources by medical residents at the *la Fe* hospital and to check their answers to questions extracted from the *MedPix* collection. Opinions gathered from the interactions

of the residents with course resources and questionnaire items revealed a general satisfaction with their instructional usefulness. One of the main features they observed is the potential of those instructional resources to link image information with radiology text reports and the way such links can be explored and evaluated by means of test questionnaires and other similar activities (e.g. forum posts). On the negative side, most users highlighted that better image visualization was required and a stronger relationship between descriptive cases and questionnaires should be established. Nevertheless, course outcomes were mostly positive, which made the educational potential of the approach apparent.

4 Conclusions and Future Work

The current work has presented the *Clavy* platform as a key element in the process of collecting, transforming and generating instructional resources in the radiology area. Through the development of a course oriented to the training of residents in radiology at the *la Fe* hospital, *Clavy* has proved to be a useful tool for tutors, not only for collecting data from these multiple and diverse information sources in a versatile way, but also to process such data by transforming the associated semantic structure and generating useful contents with instructional purposes. The outcomes concerning the participation of residents in the course have been very positive, highlighting the degree of engagement of radiology residents who enrolled in the course.

Currently we are working on supporting the exportation of *Clavy* learning objects to other e-Learning formats that support interaction (e.g., in particular, SCORM packages). We are also working on the importation of MCQs from *MedPix* and on the embedment of these MCQs in SCORM packages. Further works plan to support the IMS Common Cartridge, and also to implement new courses to assess users who could participate in a residency hospital program as part of their training (*Clavy* would help hospital tutors to generate their own contents in this training program based on the extraction of medical cases in which they are involved).

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