Crafting Vascular Medicine Training Scenarios: The RT3S Authoring Tool

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Abstract—The RT3S E-learning environment enables experts in vascular medicine to prepare educational training content for their trainees (i.e., future endovascular surgeons). Influenced by the Learning Design (LD) information model and building-upon LAMS, the learning process is realized by means of training scenarios (i.e., as an interactive sequence of learning steps). In RT3S, creating learning scenarios does not require that the editors of the scenarios are familiar with the underlying LAMS environment. The RT3S authoring environment is easy to use and customized (i.e., it can be adapted to the needs of the tutor and of the scenario) and enables tutors (e.g., expert surgeons) to easily prepare new educational content. Students (future surgeons) are trained on the assessment of real (and realistic) patient data and on decision-making processes for the management and treatment of patients.

I. INTRODUCTION

THE disease of the peripheral arteries gives rise to high morbidity and mortality rates. Around 20% of the population over 60 years old suffers from Peripheral Arterial Disease (PAD). The symptoms can become particularly severe and progressive in about 20% of these cases, causing major lifestyle limitations due to pain during walking (intermittent claudication). The progression of the disease can result in critical limb ischemia, which is the major cause of amputation resulting in approximately 5,000 amputations per year in the UK. The symptoms are more common to those who smoke, the diabetics and to patients with diagnosed arterial disease [1].

The suggested treatments for patients suffering from peripheral arterial disease include lifestyle changes, medicines and, finally, surgery. The overall goals of treating PAD include reducing symptoms, improving quality of life and preventing complications. Treatment suggestion is the result of a series of physical examinations and tests and is based on patient's physiological signs, symptoms and risk factors. Decision making for the peripheral vascular disease

can be quite complex and requires expert knowledge from an experienced doctor. In the context of training young vascular angioplasty surgeons, several training systems are known to exist [2-11]. Systems described in [8-11] are Web-based training applications specializing on safer vascular stenting, and in this regard, most relevant to the present work. An inherent limitation of all these educational systems is that the editors of educational content must be familiar with the peculiarities of the e-Learning system in use.

The RT3S training application incorporates most of the characteristics of existing training applications. It provides the required functionality for presenting, accessing, importing and exporting information about patients and their examinations. In addition, it includes a range of novel characteristics, the most important of them being that its functionality is specialized by user profile, making it easy to use by each type of users. Two different types of users are identified in RT3S, namely: (a) The tutors (typically experienced surgeons) who can also act as editors (or authors) of educational content and, (b) The learners (typically future surgeons at early steps in the specific competence). The focus of the present work is on the authoring of educational content in RT3S.

The RT3S training application provides with a highly intuitive visual authoring environment allowing tutors to create educational content according to a Learning Design LD approach, by means of learning sequences or learning scenarios [12]. Compared to existing learning applications (such as those mentioned above) the RT3S authoring system has several distinctive features, the most important of them being that: a) It does not require the tutor to be familiar with the LAMS [13] or the RT3S environment, b) It can be easily customized and adapt it to the educational level of students, c) It supports learning activities that range from individual tasks and small group works to class activities, d) It is designed as an e-Learning platform allowing the learners to be trained or take an examination test using the application on the Web.

In RT3S training application, each particular e-learning sequence is characterized by its learning goals, which can be achieved following a sequence of learning steps. This is realized as the instantiation of a generic e-learning template (i.e., an empty scenario) providing access to a set of seven predetermined learning stages forming the main building blocks of an e-learning scenario. Selecting learning stages for composing a scenario depends on the learning needs of

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the trainee and the scenario. In addition, each stage is easily customizable (allowing the tutor to define the functionality he/she has in mind). The learning template of each stage is enriched with a repertoire of tools (functions) for developing the desired learning goal. Both actions (i.e., scenario composition by selecting learning stages and putting them in a learning sequence as well as, customization of learning stages) are implemented by means of a Graphical User Interface (GUI) using buttons and pull down menus. During execution of a learning scenario, the tutors can interact with the learners or, the learners can interact with other learners.

In RT3S training application, the learners can use and process real (or synthetic) patient data, go through the whole condition assessment and, finally, take all the important decisions concerning the management and treatment of patients (diagnosis, additional examinations needed, drugs for managing other diseases the patient may suffer from etc.). Depending on the decisions taken, different pathways are activated leading to different results (e.g., risk factors and complications). Using this tool, the learners can improve their ability to select the most appropriate endovascular materials and place them in the optimal position in the artery. This functionality together with fatigue fracture risk results, predicted using efficient models for fatigue fracture of stents [14], and appropriate educational support, allows learners to enhance their interventional skills and reasoning and better understand the utility and significance of stent - location interaction.

The training application is being developed in the context of the RT3S project of the EU [15] and it is available on the Web [16]. In the following sections, the RT3S training application environment is presented putting more emphasis on the functionalities of the authoring tool.

II. RT3S TRAINING APPLICATION ENVIRONMENT

A. RT3S authoring tool

The RT3S authoring environment consists of five main working areas:

Create/Edit sequence work area where learning sequences are created or edited. Each step of a learning sequence is an instantiation of the corresponding step of the generic template. Initially, before starting a new lesson, this area is empty; activities are added and connected forming a sequence. A new learning step can be created, modified or deleted. This activity is realized as a drug and drop procedure and the results are displayed on the GUI. All changes on the learning sequence are reflected on the screen. At the bottom right corner there is a trash bin for deleting activities which are not needed [13] (Fig. 1).

Sequence management area comprising of two sections namely a) Drop down menus (i.e. File, Edit, Tools and Help menus) and b) Ten frequent task buttons (i.e. New, Open, Save, Copy, Paste, Transition, Optional Flow, Group and Review) [13] (Fig. 2).

Activity tools area providing with a number of software tools, which are the main components of a scenario. Each tool has a set of features specific to that tool, along with a set
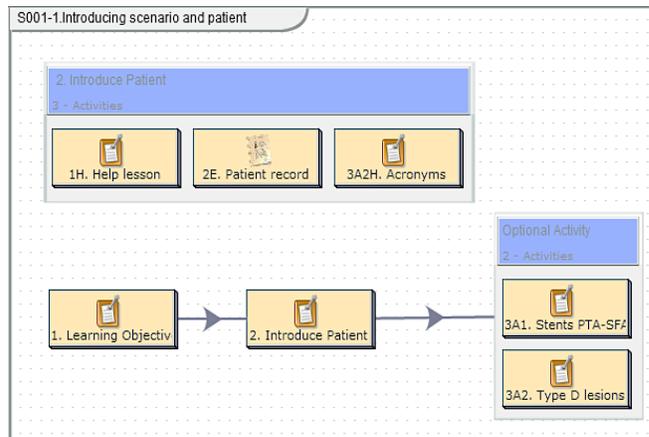

Fig. 1. Create/Edit sequence work area.

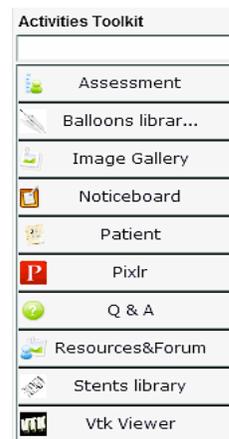Fig. 2. Sequence management area.
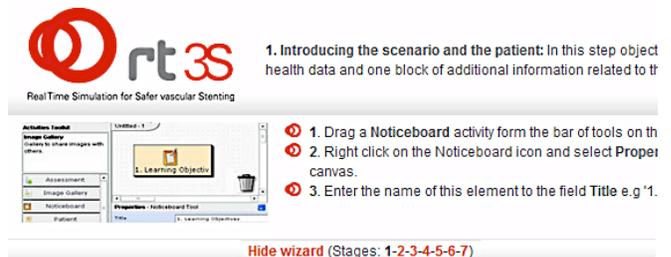

Fig. 3. Activity tools area.

Fig. 4. Wizard area.

Fig. 5. Property area.

of features that are common in all tools (Fig. 3).

Wizard area is located on the top of the screen and opens by clicking on the bar entitled "Show Wizard". The Wizard provides assistance to the trainee by instructing him/her on the necessary steps that he/she has to follow for implementing a learning stage (Fig. 4).

Property area is located at the bottom of the screen and can be selected by clicking on the "Properties" title. When a tool is selected within the author workspace, the Properties panel will display the available options for that tool [13].

B. Activity tools description

Activity tools can be grouped into four categories: Informative, Assessment, Collaborative, Reflective, and RT3S specific. Informative tools are used to post information (e.g. text, images, URL, hyperlinks, PDF's files, PowerPoint Files, Flash Files, etc.) to the learners or allow them to share information with others. Assessment tools provide with a fast and efficient way of collecting learner's responses on a topic. Collaborative tools allow learners working together to achieve specific learning goals. Reflective tools allow learners and tutors to transform the examining and interpreting experience in order to gain new understanding [13]. RT3S specific tools are also provided facilitating access to patient data, endovascular materials and results of AimaSimul [17]. The more important tools of all four categories are described below.

Noticeboard: Allows the tutor to present information in the form of text, images, links, flash files and any other HTML features to the learner, Image Gallery which allows authors and learners to upload a series of image and review them.

Image Gallery tool: Allows authors and learners to upload a series of image and review them.

Pixlr: A powerful online flash-based image editor. The editor has powerful image creation and editing features, and the interface will be familiar to anyone who has used Paint, or more advanced editors like Photoshop or GIMP.

Multiple Choices: Allows tutors to create questions for assessing the level of understanding of learners. These questions can be used for summative assessment with scores, or formative assessment with feedback

Survey tool: It is similar to Multiple Choices but, unlike Multiple Choices, there is no right or a wrong answer, the system just collates all answers for analysis by the tutor in the monitoring area. Question types include single response, multiple response and open text entry, and questions can be mandatory or optional.

Question and Answer: Allows tutors to pose questions to individual learners and view their responses. Learners according to their responses can be streamed to different branches.

Assessment tool: Allows tutors to create a series of questions with high degree of flexibility in score weighting.

Forum tool: Provides an asynchronous discussion environment for learners, with discussion threads initially created by the teacher.

Chat tool: Implements a live (synchronous) discussion tool among learners.

Notebook: This tool allows the learners to record their thoughts during a learning sequence. The input to the Notebook is automatically recorded as a fixed entry that is viewable by the teacher.

Vtk Viewer: Allows the tutor to upload 3D results (3D model of the leg or the artery etc.) of AimaSimul [17] to the learning sequence. The learner can translate or rotate the depicted object in order to have a clear view of the anatomy and the problem presented.

Patient tool: Allows the tutor to retrieve information of a specific patient from the RT3S database and present it to the learner. This can be demographic information, historical data, lab tests, medication, or an AimaSimul report.

Acronym editor tool: Inserts a table with the most common acronyms concerning peripheral arterial diseases. The table consists of two columns, one with the acronym and one column with the explanation of the acronym. The author can edit the table in order to include new acronym or to erase some the existing acronyms.

Stents library tool: presents information about the stent materials and allows the tutor to edit/add/delete elements of the library (Fig. 6).

Balloons library tool: Presents information about the balloon and guidewire materials and allows the tutor to edit/add/delete elements of the library. The tutor can add or modify entries in this table at will.

Bibliography access tool provides the authors with functionality for searching in the digital libraries of journals or conferences (e.g., PubMed [18]).

C. Common features of tools

When a tool is selected, a new window is opened, showing a number of different options available to that tool. Each has three separate areas defined as: 1) Basic, 2) Advanced and 3) Instructions. The *Basic* tab controls the content of the activity, the *Advanced* tab controls how the activity behaves and the *Instructions* tab allows authors to comment on the activity itself. The common features presented in most of the tools allow the authors to format the text, to insert images, videos, audios and hyperlinks, to use the provided templates, to insert tables, to have access to the patient card, to stent or balloon library, to create a list with acronyms, to insert information from the literatures.

D. Previewing tool

Once the author has saved a sequence (Fig. 7), she/he can view the sequence by clicking the "Preview" button: A copy of the learner window appears (Fig. 8).

The screen consists of three main parts: a) Progress Bar, b) Notebook, c) Activity tool area.

The *Progress bar* illustrates the order of activities in the sequence, as well as the current position in a learning stage. Activities completed are presented by Blue circles. Red squares show the current position (learning stage) in the sequence. Green triangles represent activities not yet reached. Red and Green boxes allow branching in a sequence. The user is allowed to follow different path-ways depending on the decision he/she is taking at this stage of a learning sequence.

The *Notebook* is positioned at the bottom-left corner of the learning environment. There the user can input notes during a sequence for later review. The notes are private (i.e., can't be viewed by other learners or the tutors).

The *Activity tool area* displays the actual content of the sequence. The user goes through a sequence of learning steps during which she/he is engaged in several activities.

During the learning sequence the learner can access the so called *supporting activities* provided by the tutor. The supporting activities are placed on the left side of the learning space under progress bar. The supporting activities can include different educational supporting materials like useful links, presentations, literature information etc.

Three command buttons appear at the top-left corner of the learning space:

Resume: Retracts to the current position in the sequence (indicated by the Red Square on the Progress bar).

Exit: Closes the Learning Environment window and returns to the "My Groups" page.

Export: Exports the entire learning sequence as completed by the learner (complete with Learner input) into a zipped file containing the sequence as a bundle of HTML files along with a directory file for accessing the various activity answers).

Once the learner has completed a learning sequence she/he can select another sequence or to start over the same on from the main learner page.

III. Conclusions

We presented the RT3S application for training future surgeons in Peripheral Artery Disease (PAD) domain. The focus is on the design and functionality of the authoring environment. Being user friendly and easy to use, it allows experts to prepare educational content for their trainees (i.e., future surgeons and interventional cardiologists). It is fully supported by a Graphical User Interface (GUI) and can be instantiated easily to the needs of virtually any medical application domain, besides PAD.

Fig. 6. Stent library activity tool.
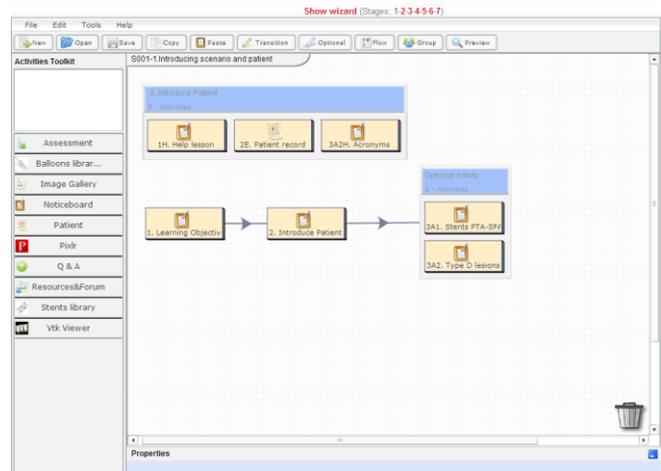
Fig. 7. Authors view of a sequence.

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