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# Personalising e-learning modules: Targeting Rasmussen levels using XML

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**Abstract**

*The development of Internet technologies has made it possible to increase the number and the diversity of on-line resources for teachers and students. Initiatives like the French-speaking Virtual Medical University Project (UMVF) try to organise the access to these resources. But both teachers and students are working on a partly redundant subset of knowledge. From the analysis of some French courses we propose a model for knowledge organisation derived from Rasmussen's stepladder. In the context of decision-making Rasmussen has identified skill-based, rule-based and knowledge-based levels for the mental process. In the medical context of problem-solving, we apply these three levels to the definition of three students levels: beginners, intermediate-level learners, experts. Based on our model, we build a representation of the hierarchical structure of data using XML language. We use XSLT Transformation Language in order to filter relevant data according to student level and to propose an appropriate display on students' terminal. The model and the XML implementation we define help to design tools for building personalised e-learning modules.*

*Keywords:*

UMVF, Rasmussen Stepladder, distance learning, personalised learning, personalised teaching, reading levels.

## 1. Introduction

The development of Internet technologies, and particularly the development of the World Wide Web has made it possible to increase the information available to students and teachers in an exponential manner. Nevertheless, the number and the diversity of resources make their use increasingly difficult. In this context of evolution, some initiatives have appeared which aim to gather and organise on-line resources. One of them is the French-speaking Virtual Medical University Project (UMVF) [1].

This project is financed by the French National Ministry for Research. The main goals are:

- to give access to validated resources within a national federative structure,
- to take all the different types of pedagogy into account,
- to allow a flexible co-operation between the various components of the UMVF,
- to give freedom to each Faculty of Medicine to personalise its site,
- to manage both on-line courses and those delivered in university classrooms,
- to provide these services to the students, the teachers, and the administrative personal from universities adhering to the project.

Each faculty and even each teacher proposes several courses on the same subjects. These courses are designed for the specific training level of students (beginners, intermediate-level learners, experts). Moreover, each course develops certain aspects of the question while summarising others.

Today, the teacher's challenge is how to transmit his knowledge in several subsets, each partly redundant, based on various teaching objectives. The student's problem is similar. He works on redundant information sources. Moreover, the learner is generally already familiar with certain elements of the course. Thus, he or she will pay particular attention to the new material. This is why providing a variable level of reading would be useful to optimise the learner's efforts.

## 2. Materials and methods

We have chosen to study a course on the subject of medical burns. We have collected a set of French on-line resources about burns. These courses are developed by different authors and target students of different levels. We have classified the information contained in these courses according to their use for recognition, action and comprehension and have studied their distribution according to the various types of documents. This analysis enables us to propose a model of organisation of knowledge derived from the Rasmussen's model [2]. We then envisage an implementation of this model to allow the creation or the reading of variable level courses. This implementation will be based on the XML language.

## 3. Results

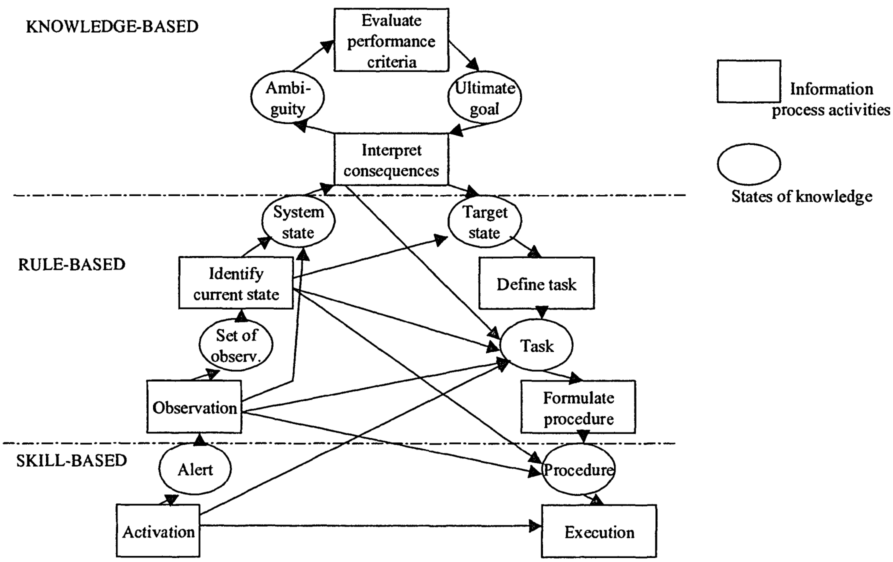


***Figure 1 - Rasmussen's stepladder model***

Rasmussen [2] has identified a decision-making process which gives an analysis of the mental activity that can occur between the perception of a signal and the execution of an action. The model in Figure 1 is analogous to a stepladder, with the skill-based and execution stages at the base (SB), rule-based stages at the intermediate level (RB) and the knowledge-based interpretation and evaluation stages at the top (KB). The diagram is arranged in the form of a two-sided ladder. On the left, there are the perceptual steps, from a low level at the bottom to a high level at the top, and on the right, there are the steps of decision or action, from a high level at the top to a low one at the bottom. Rasmussen connects the three levels he is distinguishing with three phases of learning a skill: the cognitive, associative and autonomous phases.

The medical case-study presented in this article can be represented using Rasmussen's stepladder model (Figure 2). This is a problem-solving task. The diagnosis is represented on the left side of the stepladder. It is first necessary to detect the illness of the patient (i.e. the current system state) before the decision can be taken. The medical process is represented by the right side of the ladder. Furthermore, the different conceptual levels Rasmussen identifies (skill-based, rule-based and knowledge-based) allow us to define three conceptual levels associated with three ways of facing medical problems. The student levels can thus be defined. Rasmussen's model represents a global mental process for problem-solving. This hierarchical structure of data can be represented using XML language [3]. We propose this XML model to translate the mental process data. We focus on the concepts of State, Procedure and Goal.

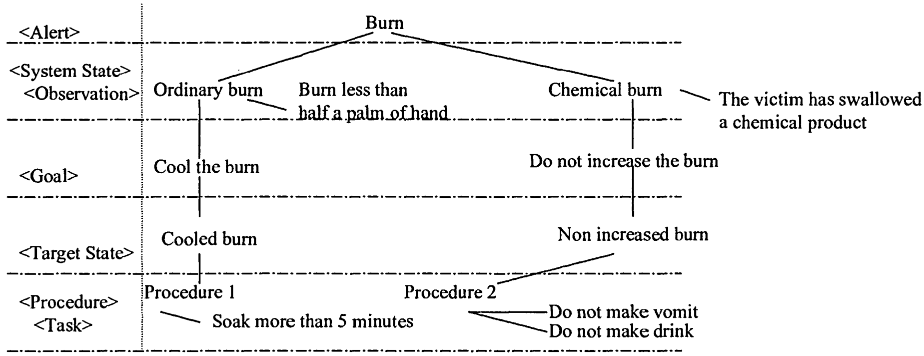


***Figure 2 - An example of problem-solving in burns***

The Structure of the XML model in Table 1 follows the global mental process for problem-solving first from the low level to high level perceptual side of the ladder and then from high level to low level action side of the ladder. From the onset, there is a signal that stimulates the beginning of the mental process. This explains the <Alert> tag defined at the top of the tree. Once the alert has been detected, it is necessary to analyse the context of the problem and so to identify the current system state before making a decision. This activity is characterised by several observations. That's why below the <Alert> tag, we define the indented tag <System State> aggregating a group of <Observation> tags. From the system state, it is possible to reach several final states (<Target State> tag) depending on the goal (<Goal> tag) the decision-maker pursues. To reach the target state, the decision-maker defines some procedures (<Procedure> tag) composed of several tasks (<Task> tag).

The next step after the definition of the XML model is its application. We suppose that the original data is contained in some web sites or other digital documents. The expert of the domain, the teacher most of the time, analyses the different documents and mutualises the relevant pieces of information from all the documents. The information thus collected is stored in XML format. It then becomes necessary to deliver the pertinent information to the appropriate students (Figure 3). Since we have already defined some conceptual levels (knowledge-, rule- and skill-based), using a first XSLT filter (Extensible Stylesheet

Language Transformations) makes it possible to select the adequate data. A second XSLT filter is used to display the data depending on the student's terminal: using HTML for web browser, WML for wap browser, etc. XML will allow us to mutualise the data that can be presented in different web sites. However, it can happen that the process remains incomplete due to a lack of information. In this case, the decision maker takes action without having been able to dispose of all the necessary information. Rasmussen has charted the possible shortcuts that human decision-makers take in real life.

| | |
|---|---|
| Skill Based (SB) | <Alert> |
| Rule Based (RB) | <System State><br><Observation>...</Observation><br><Observation>...</Observation><br><Observation>...</Observation> |
| Knowledge Based (KB) | <Goal> |
| RB | <Target State><br><Observation>...</Observation><br><Observation>...</Observation> |
| SB | <Procedure> |
| RB | <Task>...</Task><br><Task>...</Task><br><Task>...</Task> |
| | </Procedure><br></Target State><br></Goal><br></System State><br></Alert> |

***Table 1 - Proposed XML model for the mental process data***

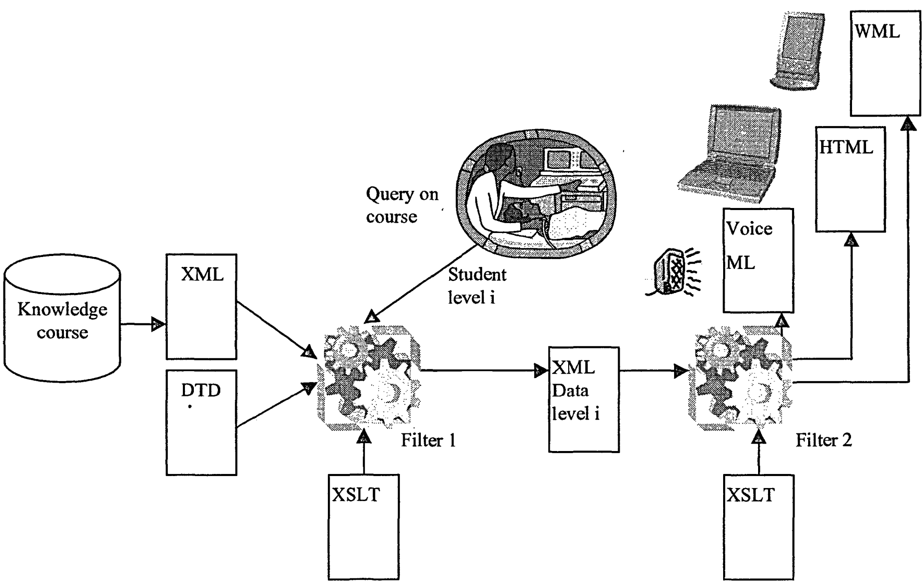


***Figure 3 - Information broadcast architecture at the victim's bedside***

## 4. Discussion

In this section, we argue the choices we have made for this work, the choice of using Rasmussen's model to design the course knowledge firstly.

Humans have a great diversity of strategies and tactics for problem-solving. Human cognitive capacity is limited. Many authors remark on the dissimilarity between the performance of the learner and of the expert, and between their supposed respective mental models. Expertise comes with practice and experience and, in any complex system, it consists of some kind of problem-solving ability. In the literature dealing with human performance of control tasks, particularly complex ones, Jens Rasmussen is a key figure [4]. He produced the stepladder model of mental processes, which has effectively become a market standard within the systems reliability community. Rasmussen makes more explicit the concepts of skill-based, rule-based and knowledge-based behaviour:

- Skilled behaviour, of which the details are largely below conscious awareness, takes direct input from the environment ('signals') and performs actions at a low level of abstraction,
- Rule-based behaviour is where the situation is categorised as requiring a particular response, like cookbook recipes not involving any reasoning, probably built up from instruction and experience. Information at this level can be thought of as 'signs',
- Where there are no pre-established appropriate rules governing a situation, knowledge-based reasoning is required, with an explicit consideration of goals, and perhaps planning or search. Here, the corresponding form of information is the 'symbol'.

Another important aspect of his diagram is that it illustrates possible 'short cuts' in mental processing between the legs of the ladder.

Secondly, we propose a specific model of knowledge representation concerning the problem-solving task. It would have been possible to integrate our model into an existing normalised model for learning objects. There is a standard for Learning Object Metadata called LOM [5] which is, in fact, a normalised description of pedagogical objects. "For this standard, a learning object is defined as any entity, digital or non-digital, that may be used for learning, education or training. The purpose of this standard is to facilitate searches for, evaluation, acquisition, and the use of learning objects. The purpose is also to facilitate the sharing and exchange of learning objects" [5]. As LOM is an open and generic model, it doesn't automatically integrate the basic metadata structure to solve our problem. This is why we adapt the Rasmussen model to e-learning in medical domain.

Finally, we propose XML as the implementation language for Rasmussen model versus HTML [6] in order to develop efficient learning tools. HTML is a Markup language commonly used to easily and quickly develop websites over the internet. As medical students are attached to hospitals nationwide, we need a relevant technical architecture which broadcasts courses to distance-learning students. A thin client in a web browser could be a cheap and simple solution. Nowadays, most websites have been developed using HTML languages. Awkwardly, HTML mixes content and presentation, unlike XML which separates content from representation. So, it's easier to find specific information in a XML page than in a HTML one. XML can be combined with XSLT Transformation Language in order to filter the relevant data according to the student level and to propose an appropriate display on the student's terminal. Generally speaking, XML is an open standard of communication and suits our needs perfectly: information mutualising, labelling, and externalising with intent to propose adapted e-learning tools to medical students.

## 5. Conclusion

One of the main aims of the UMVF is to mutualise courses geographically spread over the different French universities of medicine. Moreover, we take student level into account by adapting Rasmussen's stepladder to the medical knowledge database. As we have already defined some properties for the system state (<System State>), we can also define a set of observations to characterise the target state (<Target State>). It is possible to extend Rasmussen's model with a control feedback. After the execution of the procedure (<Procedure>), the work is not completed. Some complications may occur and the diagnosis could be wrong. It becomes necessary to control the transition from the system to the target state. The model will represent not only the decision making required to solve a medical case but also the next phase: the control. So the results of the execution activities will provide some observations that can be analysed and compared with the original and expected observations. The conclusions drawn from analysis may lead to the identification of a new state (system or target). The model we propose will help to design tools on both sides: for teachers designing the course, and for students using personalised on-line courses. We are now in prototyping phase in order to test the model on the distance-learning CERIM platform.

**References:**

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