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Short Practitioner Paper

Abstract. The paper aims to present the MEDeLEARN project, an ontology-driven virtual learning environment for Medical Information System training. The current training environment for healthcare professionals in the use of essential medical information systems in a large urban training hospital is based on conventional instructor-led training sessions. Problems arise due to the demanding nature of the hospital working environment, causing training to be cancelled or curtailed. This mode of training delivery is deemed to be inefficient and ineffective, with the danger of serious errors occurring as a consequence.

The project investigates whether a virtual learning environment can address the competency gap that exists in the training of healthcare professionals in the use of medical information systems. It explores the role of andragogy (adult learning) in the design and development of reusable SCORM conformant Learning Objects (LOs) for this medical domain. The system architecture of the MEDeLEARN system comprises the competency model (an ontology) and a content repository composed of metadata and learning objects.

The current work-in-progress is focused on conducting one-to-one interviews with healthcare professionals to establish user needs analysis for the following categories of requirements: current training materials, deficits noted, roles and responsibilities, current competencies and competency gaps. A mapping from the user needs analysis provides the data structure for the Competency Ontology. This ontological structure in turn provides the framework for personal learning paths supported by the Learning Objects under development.

The study affords a novel approach to e-learning development and deployment in its construction of an ontological framework for personalised learning in the healthcare profession that promises to be mappable to other learning domains.

Keywords: competency model, ontology driven elearning system, andragogy.

1. Introduction

The aim of this paper is to present the MEDeLEARN project, an ontology-driven virtual learning environment for Medical Information Systems training. The paper focuses on how a purpose-built ontology can determine the competencies required for specific roles within the medical domain, identify the gaps and guide the design of the learning content to facilitate the creation of personal learning paths. It also explores the role of andragogy (adult learning) in the design and development of reusable SCORM (ADL, 2001) conformant Learning Objects (LOs) to respond to the needs of professional healthcare workers.

2. Background

Many hospitals have over 50 different Medical Information Systems in operation and the requisite knowledge and skills to use these specialised applications is critical to the performance of a wide range of roles in the hospital domain. The current training environment for healthcare workers in the use of these essential medical information systems is based on conventional instructor-led training sessions both on and off site. Due to the demanding nature of the work schedules, training workshops often need to be cancelled or rescheduled. A more efficient and flexible approach to the delivery of training is required in order to avoid potentially serious errors occurring as a result of inadequate training. A recent report compiled by the Health Informational Communication and Technology (ICT) Industry Group in Ireland, "ICT's Role in Healthcare Transformation (2009)", states that a major focus needs to be placed on developing Information Technology (IT) skills and knowledge within the HSE for management, clinicians and administrators.

With the pressures imposed by the current economic climate, many organisations, particularly under-resourced hospitals, need to maximise the potential of their human resources by retraining or up-skilling employees to improve overall performance. E-learning can offer a cost-effective, efficient means of delivering the required knowledge, on demand and in any location. As no simple one-size-fits-all learning solution will adequately cater for the learning needs of this target group, it is envisaged that the proposed e-learning environment with its ontological framework and individual learning paths will more effectively address the competency gaps that currently exist in this medical domain.

3. Competency Modelling

Now more than ever, individuals need to learn and adapt in order to cope with the challenges of changing jobs, tasks and technologies. In recent years, a considerable amount of focus has been placed on competencies.

The Human Resource XML (HR XML, 2010) Consortium defines a competency as: "*A specific, identifiable, definable, and measurable knowledge, skill, ability and/or other deployment-related characteristic (e.g. attitude, behaviour, physical ability) which a human resource may possess and which is necessary for, or material to, the performance of an activity within a specific business context.*"

In recent times, a range of competency models and frameworks have been developed or are under construction in Europe and the USA. The European Dictionary of Skills and Competencies (DISCO, 2007) project provides a standardised vocabulary for the descriptions of skills and competencies. While it is not aligned to occupations, it is a thesaurus of skills and competencies based on existing standards and classifications.

The European Commission on Employment, Social Affairs and Equal Opportunities is currently creating the European Skills, Competencies and Occupations (ESCO, 2010) taxonomy, a multilingual dictionary, linking skills and competencies to occupations. ESCO's goal is to improve the interoperability of education and employment service providers, contributing to the creation of a true European labour and education market. Outputs from this project are expected in 2011.

Similar work on competencies has been undertaken in the U.S., with the creation of the Occupational Information Network (O*NET), providing a description of occupations and a classification system for occupational skills in the U.S.

A recently completed EU-funded project, The European Network for Lifelong Competence Development project (TENCompetence, 2009), created a suite of tools to support the development of lifelong competencies.

With regard to competencies in ICT, a European e-Competence Framework (e-CF) provides a useful reference model for ICT professionals, human resources managers, business and educational organisations across the European Union.

For the healthcare domain, the U.K. has a model representing the knowledge and skills required for different roles, the National Health Service Knowledge and Skills Framework (NHS KSF).

While the Irish healthcare sector is not as advanced in its adoption of a skills framework, there is evidence of progress being made in that direction and it is envisaged that the work carried out by this project will make a contribution to these future developments.

4.   The Design of the MEDeLEARN Ontology

Definitions of an ontology range from Gruber's (1993), "*An ontology is a specification of a conceptualization*" to the more abstract one by Daconta (2003), *"A branch of metaphysics concerned with the nature and relations of being.*" For the purpose of this research, an ontology can be interpreted as a formal explicit description of classes, their features, properties and restrictions in the medical domain under investigation.

Organising competencies and skills in an ontology provides implicit information and relations not easily modelled in a regular relational database system. Ontologies operate at the semantic level rather than at the logical level that database models are generally based on. This facilitates the exporting, translating and querying of data across a diverse range of systems and services (Gruber, 2009).

The MEDeLEARN ontology represents a competency model which specifies the training requirements for the members of the particular domain. The research carried out into the different skills frameworks helped to inform the structural design of the competency model. The hierarchy of roles and role descriptions are derived from the O*NET taxonomy and the competency classes are based on the NHS KSF framework. The ICT Skills requirements are aligned with the learning outcomes specified by the Health Informatics Training System (HITS) programme. HITS is an IT certification qualification for workers of all levels in the Irish healthcare industry and has recently been adopted internationally (HITS, 2010). The overall design of the competency ontology was also validated by a user needs analysis conducted in a large urban hospital, using interviews and surveys with subject matter experts and target learners.

The ontology is built in Protégé 3.4.1, which uses the knowledge representation language Web Ontology Language (OWL). This language is based on logic which is machine-interpretable, designed to be read by computer applications rather than humans (Daconta, 2003). A partial representation of the MEDeLEARN ontology can be seen in Figure 1. The structure illustrates the competency requirements for the medical domain and traces the path to the training requirements for the Tallaght Educational and Audit Management System (TEAMS) application, which is the focus of this project.
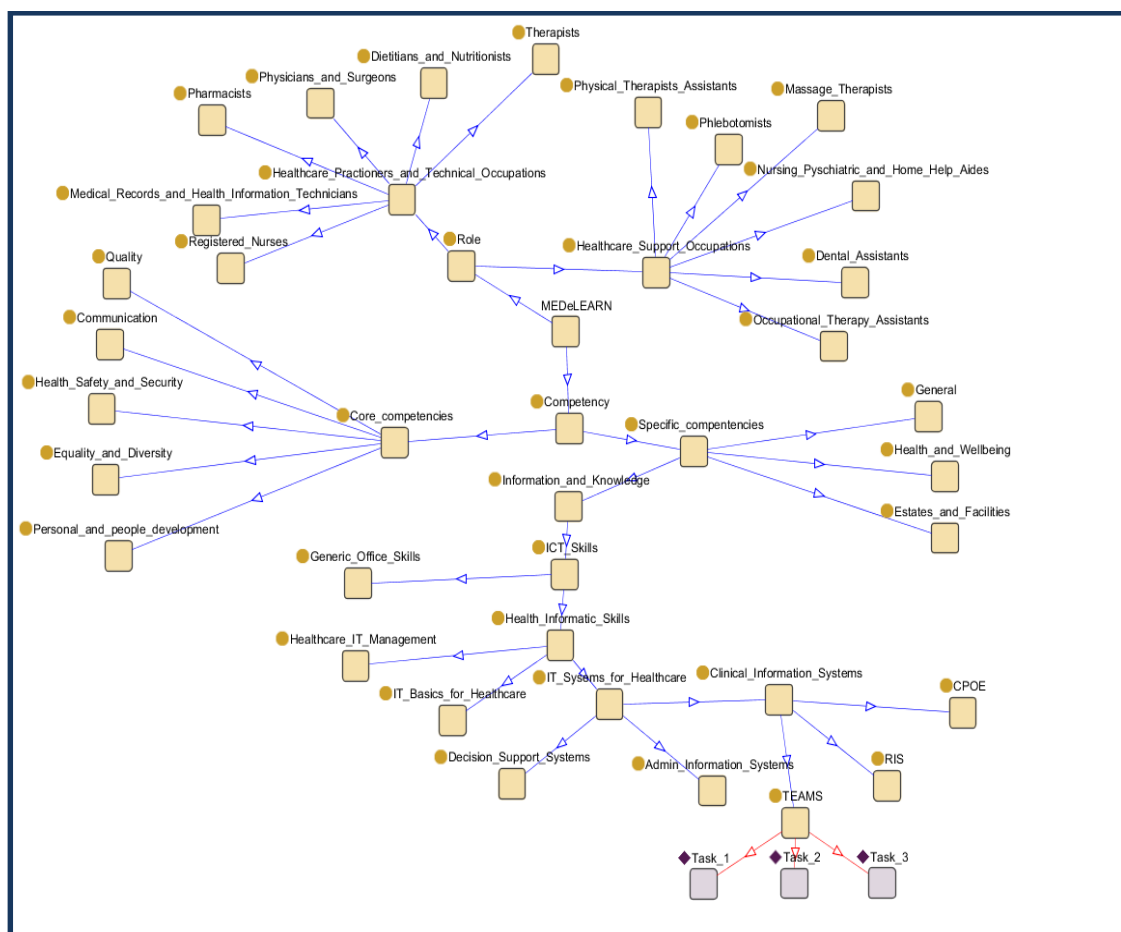

Figure 1: MEDeLEARN Ontology (partial)

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5.   Using an Ontology to Identify Learning Needs

As the ontology defines roles and required competencies in the medical domain, it can be interrogated to establish whether a competency gap exists between an individual's profile and the competency requirements specified for a particular role, i.e. profile matching. If a gap is determined, a learning opportunity is suggested and the relevant learning objects identified.

This competency ontology has the potential to facilitate the creation of personalised learning paths, catering for diverse learning needs. It also has potential to assist the Human Resources department in developing its plans for training and development.

However, it is worth noting that as both the required knowledge for a role and the experiences of the individual learner are constantly changing, the ontology needs to be dynamic and consistently maintained (Dorn, 2007).

6.   Instructional Design and Learning Content

The learning content will be designed as reusable Learning Objects (LOs), mapped to the competency requirements specified in the ontology. Figure 2 illustrates the system architecture on which the MEDeLEARN environment is based. It includes the following components: the competency ontology, the user context (individual characteristics, the organisation, work processes and tasks) and the content repository composed of metadata and LOs.
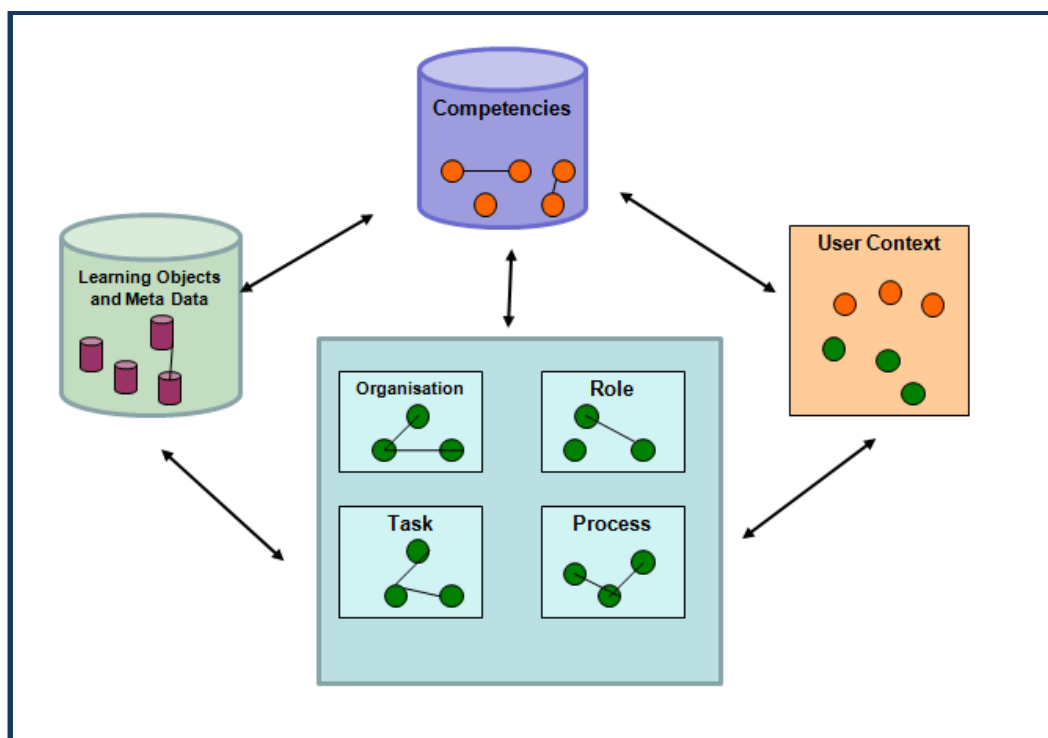

Figure 2: MEDeLEARN Architecture (adapted: Schmidt, 2008)

The instructional design will be guided by the principles of andragogy or adult learning (Knowles, 1970) to devise learning strategies appropriate for the target group of healthcare professionals. Multimedia learning principles will enhance the effectiveness of the use of different media, such as text, audio and graphics (Clark, 2008). Formative and summative assessment will be incorporated into the learning material to establish that the learning objectives have been achieved. In addition, the LOs under development will comply with international standards such as SCORM (ADL, 2001) to facilitate reuse of content across multiple institutions and platforms. SCORM conformant learning objects are more easily accessible, interoperable, durable and reusable and can be delivered to learners via any SCORM-compliant Learning Management System (LMS).

Evaluation of the learning environment will be conducted with the target group in a pilot test in the hospital to assess the content quality, learning goal alignment and usability.

7.   Conclusion

The problems identified in the current training environment for healthcare professions offer an opportunity to design an innovative learning environment which specifically addresses the competency gaps of the target group. Research has been carried out into the relevant areas to inform the design of an effective competency based, ontology-driven virtual learning environment for Medical Information Systems training. The learning needs have been derived from existing skills frameworks as well as an in-depth user needs analysis undertaken in the medical domain. A competency ontology has been built which determines the learning material required and facilitates the creation of individual learning paths. Furthermore, an appropriate instructional design for the group of professional learners has been established and research into the relevant e-learning standards has been conducted.

This project not only provides a novel approach to e-learning development and deployment in the healthcare domain, it provides a design framework which is mappable to other learning domains.

8.   Acknowledgements

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