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An Approach to Enrich Online Medical Problem-Based Learning with Tacit Healthcare Knowledge

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Abstract

Existing Problem-Based Learning (PBL) problems, though suitable in their own right for teaching purposes, are limited in their potential to evolve by themselves and to create new knowledge. Presently, they are based on textbook examples of past cases and/or cases that have been transcribed by a clinician. In this paper, we present (a) a tacit healthcare knowledge representation formalism called Healthcare Scenarios, (b) the relevance of healthcare scenarios in PBL in healthcare and medicine, (c) a novel PBL-Scenario-based tacit knowledge explication strategy and (d) an online PBL Problem Composer and Presenter (PBL-Online) to facilitate the acquisition and utilisation of expert-quality tacit healthcare knowledge to enrich online PBL. We employ a confluence of healthcare knowledge management tools and Internet technologies to bring tacit healthcare knowledge-enriched PBL to a global and yet more accessible level.

Keywords:

Problem-Based Learning; Healthcare Scenarios; Tacit Healthcare Knowledge

1. Introduction

Problem-Based Learning (PBL) is a cognitive paradigm in which a student learns through solving a certain problem. The rationale for posing problems is so that the student is motivated to hold discussions and independently learn new knowledge in order to solve the problem at hand [1]. PBL has been utilised to train medical students since the 1960s in view that students found it difficult to apply the relevant skills and knowledge into the real-life practise of medicine [2].

Presently, medical PBL problems are based on textbook examples of past cases and/or cases that have been transcribed by a clinician. We argue that these existing PBL problems, though suitable in their own right for teaching purposes, are limited in their potential to evolve by themselves and to create new knowledge. Furthermore, healthcare institutions are sometimes faced with the problem of procuring PBL problems. We believe that current healthcare PBL problems can be brought to a higher level of abstraction that will allow healthcare experts to use their tacit knowledge to generate PBL problems that are of added-

value with the injection of tacit healthcare knowledge and thus alleviating the problem of acquiring new PBL problems.

Tacit healthcare knowledge is non-formalised healthcare knowledge. It is the kind of knowledge that governs the healthcare experts' skills, common sense and intuitive judgement. Due to the abstract and informal nature of tacit healthcare knowledge, the state-of-affairs vis-à-vis healthcare tacit knowledge acquisition does not commensurate with the importance of tacit healthcare knowledge, thereby resulting in the under-utilisation and non-documentation of such a vital component of the overall healthcare education and delivery system [3].

To address the above issues, we present (a) a tacit healthcare knowledge representation formalism called *Healthcare Scenarios* [4], (b) the relevance of healthcare scenarios in PBL in healthcare and medicine, (c) a novel PBL-Scenario-based tacit knowledge explication strategy and (d) an online PBL Problem Composer and Presenter (PBL-Online) – a sophisticated client-server PBL system that combines the effectiveness of PBL-Scenarios and the Internet – to facilitate the efficient acquisition and utilisation of fresh and dynamic expert-quality tacit healthcare knowledge from healthcare experts in order to enrich medical PBL.

2. Tacit Healthcare Knowledge Representation using *Healthcare Scenarios*

A healthcare scenario is a customised, goal-oriented narration or description of a healthcare situation. It includes the specification of actors, events, outputs and environmental parameters. Healthcare scenarios may be composed of four main components [4, 5, 6]: *Meta-Scenario*, *Scenario-Construct*, *Healthcare Episode* and *Healthcare Event* (see Figure 1). Healthcare scenarios can be represented by a four-tier scheme where Meta-Scenarios are placed at the top level followed by Scenario-Constructs, Healthcare Episodes and Healthcare Events at the bottom level. Just as knowledge bases store rules for healthcare expert systems, the healthcare scenario components are stored in *scenario bases* which also adhere to the same hierarchical scheme.

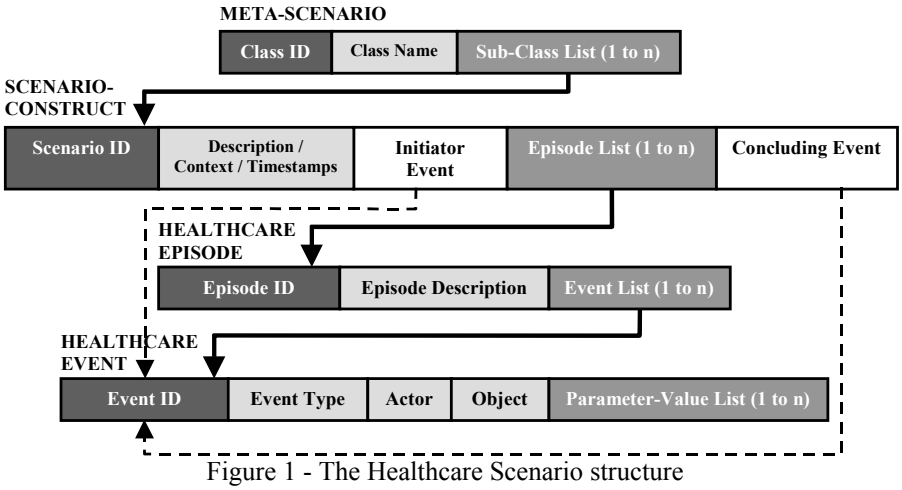

Figure 1 - The Healthcare Scenario structure

Of these four main components, the key components of the healthcare scenario are actually the Scenario-Construct and Healthcare Event components. The Scenario-Construct stores all background information pertaining to individual healthcare scenarios. It also ensures the correct sequencing of Healthcare Episodes and Events. The Healthcare Event stores the details of a healthcare scenario including the Event Type (which could be *Normative*, *Obstacle* or *Action*) and the various event parameters and their values.

Therefore, a healthcare scenario can be viewed as a sequence of real or hypothetical healthcare events encountered by healthcare experts together with their responses or actions. An example of a healthcare scenario is the procedures (investigations, differential diagnoses, treatment, etc.) undertaken to treat a patient with urinary tract infection.

3. The Relevance of Healthcare Scenario in Problem-Based Learning

We have observed that current medical PBL materials are also in the form of problem narrations. Each problem is presented in sections called *triggers* over the course of a certain time period, usually one week. Medical PBL problems/triggers typically begin with some background description of the problem followed by events that happened (e.g. complications, improvement, etc.), actions that were carried out by a clinician, laboratory test results and other details.

With the above details in mind, we are able to adapt our healthcare scenario representation to suit the dynamics of medical PBL. We have noticed that it is common to have two or three triggers pertaining to a particular PBL problem which can be decomposed into a number of sub-problems similar to that of our Healthcare Episodes. Therefore, we introduce another component to our healthcare scenario structure to accommodate these triggers. The resultant structure is what we will call a *PBL-Scenario* with five main components: *PBL Meta-Scenario*, *PBL Scenario-Construct*, *PBL Trigger*, *PBL Episode* and *PBL Event.*

4. Utilising PBL-Scenarios: A Tacit Healthcare Knowledge Acquisition Method

Our tacit healthcare knowledge acquisition exercise distinguishes between three types of PBL-Scenarios:

1. *Solved PBL-Scenarios*: These are PBL-Scenarios that define actual clinical situations/problems that have already been encountered and solved by healthcare experts. Such scenarios are records of complete descriptions of typical or routine clinical situations together with the expert's responses.
2. *Challenge PBL-Scenarios*: These are PBL-Scenarios that represent atypical situations and are posed to healthcare experts as challenges to their expertise. We argue that tacit knowledge is best explicated when experts are required to solve atypical problems in line with contrived knowledge acquisition approaches [7]. Challenge PBL-Scenarios are derived from existing Solved PBL-Scenarios or Solved Challenge PBL-Scenarios by way of selecting a *Point of Interrogation (POI)*, i.e. a distinct point in the PBL-Scenario between two PBL Event of type *Obstacle* or *Normative* and a PBL Event of type *Action*. The result is a Challenge PBL-Scenario which is then presented to a healthcare expert for the explication of his/her tacit healthcare knowledge (see Figure 2).
3. *Solved Challenge PBL-Scenarios*: These scenarios originate from Challenge PBL-Scenario that have been completed or solved by a healthcare expert and are deemed as the encapsulation of the healthcare expert's tacit knowledge (see Figure 2).

	Trigger	Episode	Event	Event Description	
PBL-Scenario 5 month old boy with history of fever for 6 days prior to admission	Trigger		Initiator Event EV0001 Obstacle	Patient admitted with fever, decreased appetite and vomiting several times a day. Frequency of passing urine is decreased.	
		Episode	EV0002 Action	Perform anthropometry.	Challenge
			EV0003 Obstacle	Weight = 4.8 kg (p10 = 6kg). Length = 55cm (p10 = 61cm). Head circumference = 40cm (p10 = 40.5cm).	
			Action	Check condition.	POI
			Obstacle	Patient is ill looking, lethargic and showing signs of mild to moderate dehydration.	
	. . .				Expert's Response + Tacit Knowledge
			Concluding Event Normative	Patient responding well to treatment and is discharged. Arrange a review in 1 month.	

Figure 2 - The expert's response to the Challenge in a Solved PBL-Scenario

The Solved PBL-Scenarios are then subjected to a process of peer evaluation. The discussion on this process is beyond the scope of this paper. However, suffice to say that this process allows healthcare experts to assign ratings to the PBL-Scenario components based on their relevance and usefulness. This leads to the crystallisation of healthcare tacit knowledge [4].

5. PBL-Scenario-based PBL-Online System

To enrich current PBL problem repositories and to facilitate the explication of tacit healthcare knowledge, we are in the midst of developing an online *PBL Problem Composer and Presenter (PBL-Online)* – an intelligent web-based system that allows healthcare experts to systematically respond to atypical PBL-Scenarios. To achieve this, PBL-Online presents web-based knowledge elicitation forms (see Figure 3) which contain attributes that correspond to the PBL-Scenario structure. These prompt healthcare experts to provide information or suggest probable and realistic values to the various PBL-Scenario attributes presented in the forms thus creating new PBL problems that are of added-value and enriched with expert-quality tacit knowledge. PBL-Online is a step-forward compared to the stand-alone version of our legacy Healthcare Scenario Composer [4, 8].

PBL-Online also includes healthcare ontology/thesaurus-based consistency-checking mechanisms to standardise the input of the healthcare experts because, as it turns out, there are no restrictions on the terms used by healthcare experts [9]. For our purpose, we will incorporate the MeSH thesaurus.

In addition to facilitating the explication of tacit healthcare knowledge, PBL-Online functions as a full-fledged medical PBL problem presentation system that allows coordinators, facilitators and students to prescribe and view the scheduled PBL problems and triggers.

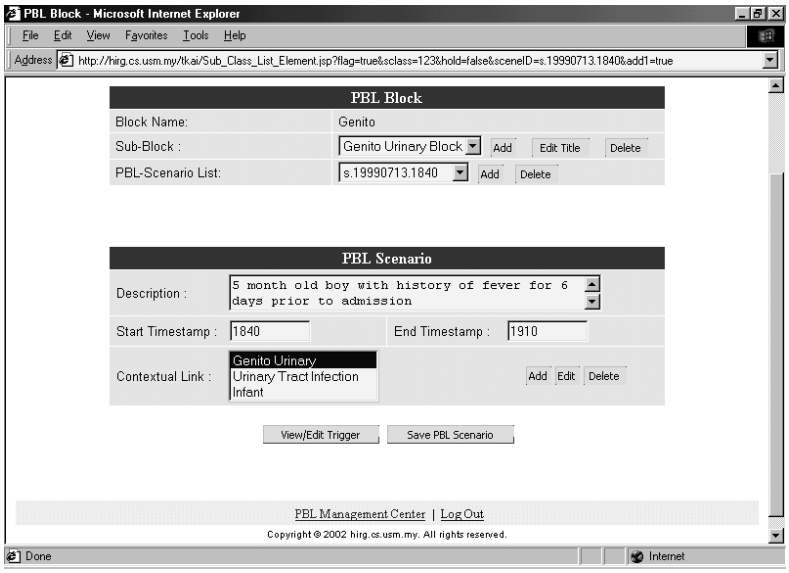

Figure 3 - Sample PBL Scenario-Construct form

5.1 PBL-Online for Students

Upon logging-in to PBL-Online, the students would first be presented with the PBL trigger for the session in narrative format. The students can then input notes in the form of key points, hypotheses and learning issues in the text boxes provided. Students can also view the PBL trigger's recommended key points. The key points are derived directly from the hierarchical Solved PBL-Scenario for the corresponding PBL trigger narration. Finally, students are allowed to answer a number of discussion questions based on the PBL trigger. Their answers will be evaluated by the PBL facilitator and students are allowed to proceed to the next PBL trigger only if they achieved a predetermined score.

5.2 PBL-Online for Coordinators and Facilitators

PBL coordinators are allowed to prescribe PBLs to the students. They can also edit the narrations, recommended key points (i.e. the Solved PBL-Scenario) and discussion questions. Facilitators monitor the PBL sessions and evaluate the students answers once the deadline for answers has passed (see Figure 4).

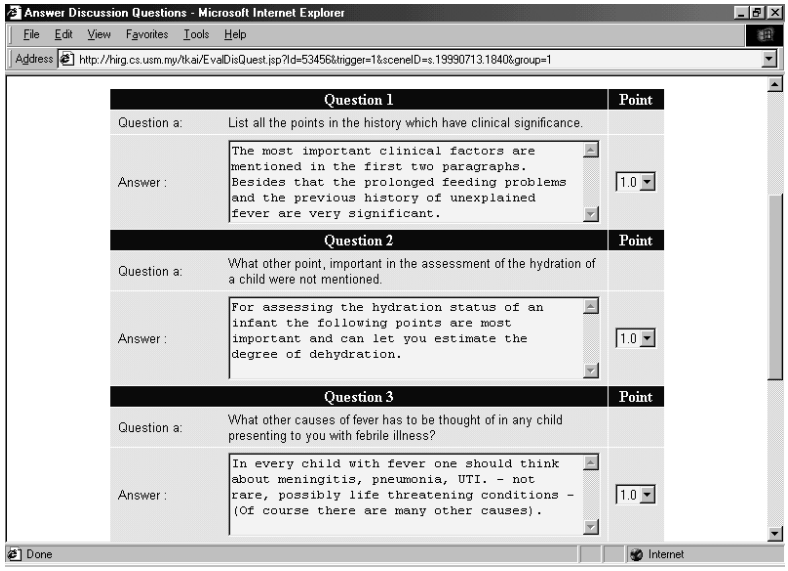

Figure 4 - Student evaluation form

6. Concluding Remarks

We believe that the PBL-Online system presented here does provide an all-rounded facility to enriching the overall PBL initiative through the addition of explicated tacit healthcare knowledge. In this paper, we discussed an approach to explicate and represent tacit healthcare knowledge with the aim of extracting the essence of the healthcare experts' problem-solving methodology. We also presented the PBL-Online system and its components that function as both a PBL presentation system as well as an authoring tool to enrich the PBL-Scenario base with tacit knowledge-enriched PBL problems. PBL-Online employs a confluence of healthcare knowledge management tools and Internet technologies to bring tacit healthcare knowledge-enriched PBL to a global and yet more accessible level.

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