An Interactive Case-Based Flip Learning Tool for Medical Education

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Abstract. Legacy Case-Based Learning (CBL) medical educational systems aim to boost the learning and educational process but lacks the support of *Systematized Nomenclature of Medicine* (SNOMED) and flip learning concepts. Integrating these vocabularies can exploit the learning outcomes and build confidence in students while making decision to rehearsal in advance before attending the actual CBL. The scope of this research covers delivering of medical education in interactive and intelligent way, efficient knowledge sharing, promoting team work environments, and building a knowledge-base for future to support automated computerized feedback. To achieve these goals, we propose a tool called *Interactive Case-Based Flip Learning Tool* (ICBFLT) that covers formulation of CBL case summaries, getting standard computerized help from both SNOMED vocabulary and state of the art solutions, and finally getting feedback from concerned tutor. In order to evaluate the ICBFLT, a scenario from the *School of Medicine, University of Tasmania, Australia* has been considered. This is an ongoing work and this paper gives an overview of the ICBFLT architecture with some intermediate results. The evaluation shows that the system has satisfied its users in term of interaction upto 70%.

Keywords: Flip learning, Case-based learning, Natural Language Processing, SNOMED

1 Introduction

Medical education is experiencing one of the deepest revisions that has practiced in recent decades. In medical education, most of the literature is describing the Problem-Based Learning (PBL). The Case-Based Learning (CBL) is a kind of teaching in which PBL principles are followed. CBL proceeds on many forms, from simple hands-on, in-class exercises to semester long projects and/or case studies [1]. This approach promotes the learning outcomes and build confidence in the students while making decision to practice in real life [2],[3]. We have to take care about their learning systems so that medical students can easily grasp and memorize the knowledge. In order to boost the learning capabilities, we preferred the *flip learning* approach [4] as latest research recommend this approach [5], [6]. Kopp [7] defines that "a flipped class is one that inverts the typical cycle of content acquisition and application so that students gain necessary knowledge before class, and instructors guide students interactively to clarify the problem and then apply that knowledge during class".

There exists a large number of case-based tutoring and learning systems like COMET [8], MR Tutor [9], Reflective Learner [10], eCASE [11], and Turfgrass Case Library [12] that aim to boost the learning and educational process but from our best knowledge, none of them supports the formulations of cases summaries using SNOMED and flip learning concepts. Similarly, Batool et al. [13] described a mapping and transformation system for hospital discharge summaries using natural language processing without flip learning concepts. The motivations to build this system are to : 1) improve brainstorming skills, 2) retain knowledge in interactive and easy way, 3) formulate the case summaries with the help of standard SNOMED vocabulary and domain knowledge, and 4) provide the right information at the right time to right student. To achieve these goals, we proposed a solution called *Interactive Case-Based Flip Learning Tool* (ICBFLT). The online flip learning concept with incorporation of an expert system will provide standard terminologies from SNOMED vocabulary during formulations of cases summaries and will capture new knowledge. This new knowledge will provide automatic computerized feedback to help the students for solving their CBL. With the evolution of knowledge stored in database, this tool hold better clinical competence and will provide intensive learning in future [14].

In order to evaluate the ICBFLT, a scenario from the *School of Medicine, University of Tasmania* (UTAS), *Australia* has been considered.

2 Proposed System Architecture

For interactive formulation of cases summaries, an architecture is proposed as shown in Fig.1 that consists of two major components called *CBL Portal Interface* and *Expert System*. In our proposed system, there are three types of users. (i) Administrator/Coordinator: which manage the cases data, (ii) Tutor: which manage CBL cases, evaluate the CBL students' solutions, and provide feedback, and (iii) Medical Student: which solve the CBL case and get feedback. The outputs of this proposed tool are the cases summaries formulated by students and tutors, assessments of students solutions, and tutors' feedbacks. The *CBL Portal Interface*, a web application where multiple types of users are managed according to their roles and privileges.

2.1 CBL Portal Interface

This component acts as an intermediate layer between user and expert system. This component manages four subcomponents named *Case Management, Stu-*

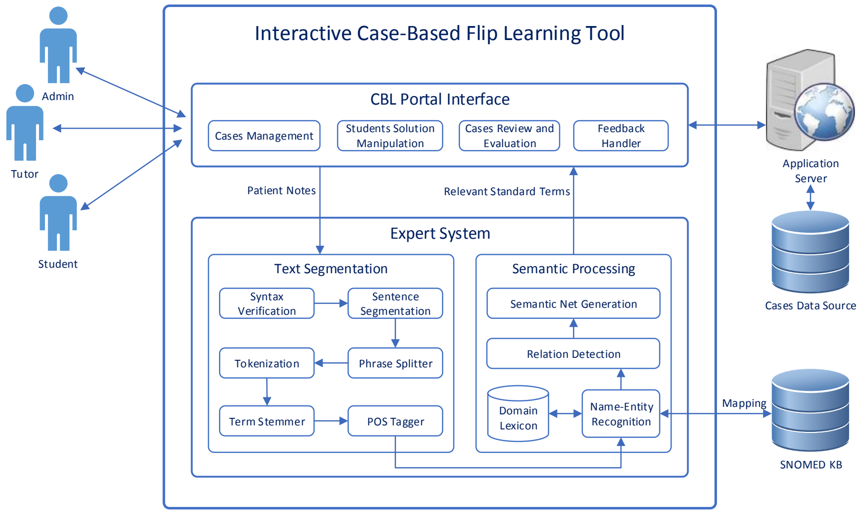

Fig. 1. Interactive case-based flip learning tool architecture

dents Solution Manipulation, Cases Review and Evaluation, and *Feedback Handler*. The *Case Management* subcomponent is used to add, view, edit, and delete the CBL case. Similarly, the *Students Solution Manipulation* subcomponent is used to add, view, edit, and delete own CBL solution, and also view other students solutions to get help and for better analysis during CBL solution. While, the *Cases Review and Evaluation* subcomponent is used to review and evaluate the students solution. Similarly, the *Feedback Handler* subcomponent provides feedback to student.

2.2 Expert System

This component is an intelligent part of the system that will provide relevant standard medical terms from SNOMED or domain lexicon during cases formulations. This component uses the *Natural Language Processing* and *Ontologies* concepts. This component is divided into two main components *Text Segmentation* and *Semantic Processing*. The basic functionality of *Text Segmentation* component is to divide the text into useful terms. Then *Semantic Processing* component takes the chunks and finds the semantics and finally sends related standard medical terms to user. The work flow for this component is described by *Relevant Standard Data Extraction Algorithm* as shown in Algorithm-1.

3 Evaluation Methodology

In this section, *CBL Portal Interface* of proposed system is evaluated. This section is divided into three categories called *Experimental Design*, *Experimental Execution*, *Experimentation Results*.

Algorithm 1: Relevant_Standard_Data_Extraction($D = pn$)

```
Data: D = pn: Input dataset (patient note)
Result: Relevant standard medical terms
if Verify(D) then
    DataSegmenter(D) : D = s_1, s_2, s_3, ..., s_n ;
    for ∀ s_i ∈ D do
        PhraseSplitter(D.s_i) : s_i = ph_1, ph_2, ph_3, ..., ph_n ;
        for ∀ ph_j ∈ s_i do
            Tokenizer(D.s_i.ph_j) : ph_j = tkn_1, tkn_2, tkn_3, ..., tkn_n ;
            for ∀ tkn_k ∈ ph_j do
                stemmedword = TermStemmer(D.s_i.ph_j.tkn_k) ;
                taggedword = POSTagger(stemmedword) ;
                return taggedword
            end
        end
    end
    StopwordRemoval(taggedword) ;
    NameEntityRecognizer(taggedword,SNOMED) ;
    if Mapping==null then
        NameEntityRecognizer(taggedword,DomainLexicon) : ;
    end
    relatedtuples = RelationDetection(listoftuples) ;
    SemanticNetGeneration(relatedtuples);
else
    Error(message);
end
return relevantstandardterms
```

In **Experimental Design**, we select the survey process. For this purpose, a case scenario is built and then after selecting evaluating variables [15] as shown in Fig.3, multiple questions are prepared for survey.

In **Experimental Execution**, some important functionalities of *CBL Portal Interface* is shown in Fig.2. Fig.2 representing tutor and student views. The tutor view describes the details of CBL case, in which tutor can add, edit or delete any information that he/she has already added. Similarly, student view describes that student can edit or delete any information that he/she has already added. Moreover, while solving the CBL case, the student can also view other students solution like patient notes of *Presenting Complaint* information. Moreover, timer concept to count the time to complete this task helps tutor to assess the student and find the difficulty level of case in future for that particular group of students.

In **Experimental Results**, after performing survey, we get feedback from nearly 54 persons regarding the system usability under multiple criteria. We classify our users into 3 groups on the basis of their responses, into poor, average, and excellent. The analysis of chart as shown in Fig.3 represents the comparison of the evaluation under different categories to reflect the perfection of system in comparable aspects. Nearly 70% of the users show confidence on system capabilities and interface interaction. They are quite satisfied with respect to interaction with the system. About 50% of users are satisfied with the consistency, screen flow and learning aspect. The alarming indication is that less than 40% of users are satisfied with load on human memory and number of actions performed for a particular task. On average 42% of users registered their level of satisfaction as medium level for the evaluating criteria of the system.

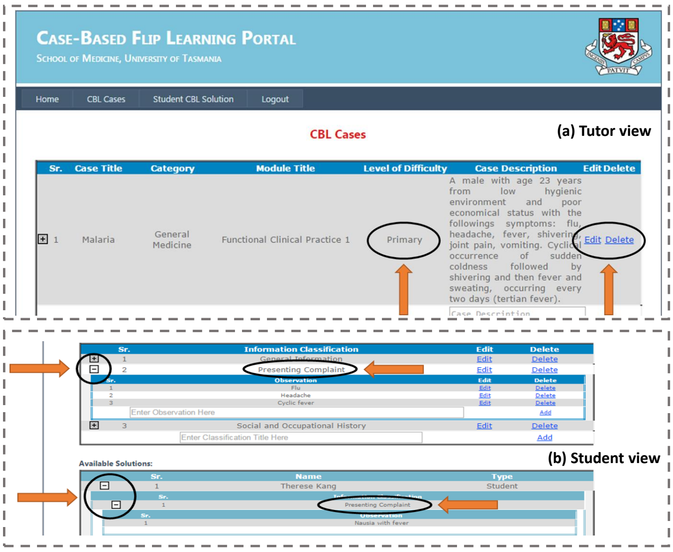

Fig. 2. Tutor and student views

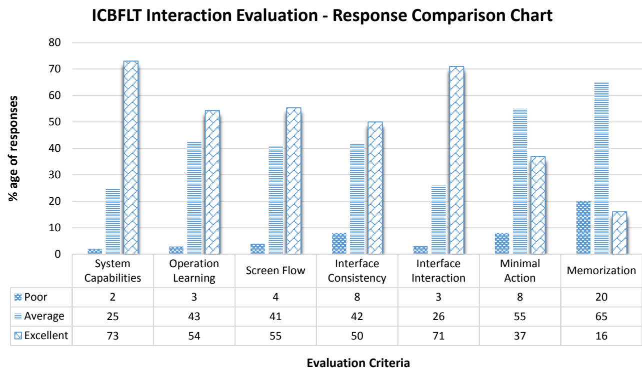

Fig. 3. ICBFLT interaction evaluation - response comparison chart

4 Conclusion and Future Work

The work describes a tool for case-based learning using new concepts including *flip learning*, *incorporation of SNOMED vocabulary*, and *role of expert system using Natural Language Processing (NLP) techniques*. The tool will help medical students to solve their CBL case intelligent and interactive manner and will boost the learning and educational process. The tool can work as a framework for managing the learning in any subdomain of medicine. In future work, flip learning and incorporation of SNOMED knowledge base will be done that will support computerized standard help regarding solving the CBL case.

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