Computer Aided Design in Medical Domain: A New Viewpoint Towards Computer Aided Education

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1 Introduction

This research focuses on the development and usage of computer aided learning (CAL) systems in medical domain. It argues that the development and usage processes should be considered as one holistic process, namely process of *development and use*. A software system is required which is able to facilitate the whole *development and use* process. This paper proposes model of the *development and use* process for the medical domain and subsequently specifies a computer aided design environment for creation of interactive simulation models of human body organs. The research and implementation discussed in this paper are performed in frame of the InterSim project (Kinshuk et al. 1998) which aims to develop learning support systems for medical education with major focus on simulations.

2 Argumentation

The advantages of educational computer systems have been recognised by the researchers more then 40 years ago (Skinner, 1958). Today, despite the great amount of research done towards discovering the "right" model of CAL system we still do not find as many educational software in practice as were hoped. Even the available educational systems do not play significant role in everyday social life compared to other classes of computer systems such as office systems, information systems and so on. It is envisaged that the "right" system model is necessary but having such model is not enough prerequisite for a wide

spread use of these systems. Aiming wide acceptance of CAL systems, having the good system model (the Intelligent Tutoring Systems, for example), an investigation should also be performed toward how the everyday life processes will enable the development and distribution of these systems. A model of *development and use* process should be created to find out how the developers and users are getting benefits from participation in the process and how this leads to wide acceptance and use of the CAL systems. A realistic implementation is based on benefit oriented models (Eskenasi et al. 1993). Further, by considering the context in which the development and usage processes are carried out, a set of software systems (CAL systems, authoring system and so on, i.e. systems which should support the ongoing processes) can be defined and the basic features of these systems must be specified. This way of modelling can outline the proper model of the CAL systems and can ensure their wide acceptance.

3 Process Model for Medical Domain

A model of the *development and use* is proposed (Fig.1) which differs from traditional model (Fig.2) with respect to the reorganised communication/ interaction channels between the actors and with respect to the increased amount of benefits for the actors. The reorganised communication channels preserve the existing form of interactions between the domain experts and between students and teachers, thus providing better communication and collaboration facilities. Increased amount of benefits for the actors together with the preserved communication/interaction channels facilitates the introduction of the new technology.

In the traditional process (Fig.2), developers develop particular CAL system by consulting domain experts and/or teachers to determine what the system should teach (Domain Knowledge) and by consulting teachers and pedagogic experts to determine how the system should teach (Pedagogical Knowledge). Practice has shown that resulting CAL system reflects views of only those developers, teachers, and domain experts involved in the development of particular CAL system and hence the system is usable only to very few students. The usage part of the traditional process restricts the interaction between student and teacher, because student is expected to interact with the system rather than discussing the topic with the teacher. In short, traditional approach lacks provision of collaboration between developers, experts and students resulting such CAL systems which do not have desired properties, are very expensive and are not quite usable.

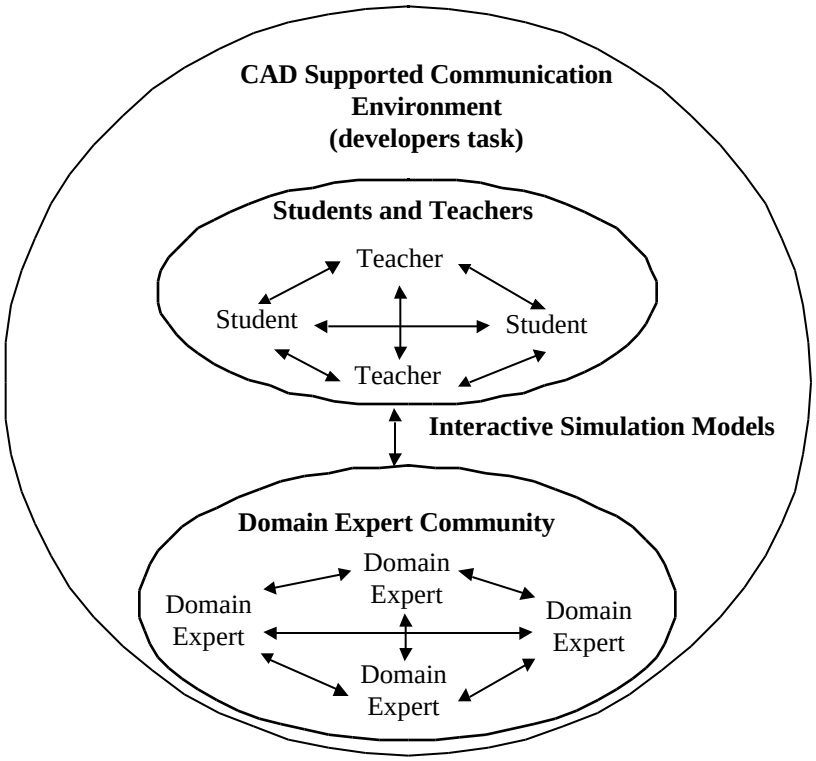

Fig.1 Model of *development and use* process for medical domain.

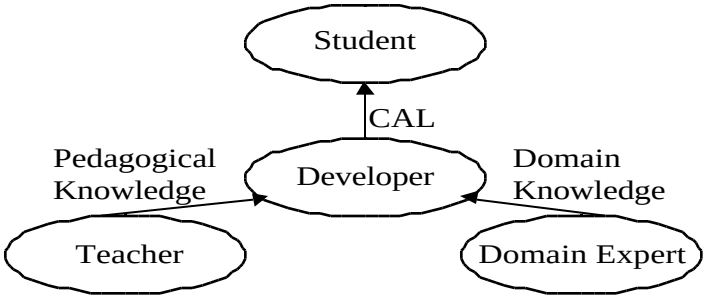

Fig.2 Model of **traditional** *development and use* process.

The proposed process model (Figure 1) assigns different tasks to the actors (domain experts, teachers, students and developers). It aims to preserve the interaction pattern within the domain and to provide every actor a more efficient

way of completing his/her usual tasks. To achieve this goal, the process model relies on sophisticated software system. For the medical domain, focus of this paper, this software system is proposed to be a computer aided design (CAD) environment for creation of interactive simulation models of human body organs. CAD environment is described later in the paper.

There are two groups of users within the process and the CAD environment is adapted to the needs of both groups. First group is domain expert community, including medical researchers and medical doctors. Second group is academic community, including medical students and teachers. First group will use the environment as a communication media to perform, present and discuss research activities within community. Such utilisation will result in acquisition/creation of various qualitative simulation models of human body organs. For the second group the CAD will serve as CAL system. Medical students will explore simulation models to acquire competence and skills. Teachers' task is to provide adequate pedagogical knowledge within the system. In comparison to CAL, CAD environment provides excellent facilities for synchronous and asynchronous communications between students and teachers in form of expressing ideas/ knowledge by creating simulation models.

The task of the developers is to create the CAD environment and continuously improve it. Motivation for developers is the expectation for high returns of their investments, due to the huge installation base that process model aims to achieve.

4 Software to support the process

Following are the key features of the CAD environment that will provide helpful assistance to the community of medical experts:

1. The design paradigm of the CAD allows the ease in creation of the models. Domain experts should be able to present knowledge for a given organ without much design overload.

2. The design paradigm provides modelling of the three-dimensional structure and the functionality of human organs.

3. The designing paradigm supports creation of models, which possess natural reflectivity. For example, if for some reason the blood supply for a given organ is interrupted then the model of this organ should present subsequent effects. This behaviour of the organ should be modelled without explicitly defining all possible cause-effect chains.

4. The design paradigm allows greater reusability. For example, doctors should be able to model most of the diseases for typical organs just by using the model of the healthy state organs and adding parameters for disorders causing this disease. The system should allow the users to modify

the model in case the model is not behaving according to the expectations or some required parameter is missing from the definition.

5. The environment provides greater interactivity in design and navigation of the model.

6. The environment offers facilities to determine the consistency and correctness of the models produced by the user.

To support the academic community, CAD environment will provide the teachers the facilities for implementing learner models (Self, 1988) and various tutoring strategies. The implementation is based on object-oriented technology and relies on the fact that every model of human body organ, which experts create, will posses build-in features for implementation of learner models.

5 Conclusion

This paper presented an alternative approach for *development and use* of CAL in the medical domain. It is expected to provide significant advantages in comparison to the traditional approach which aims to develop separate CAL applications primarily for educational purposes. It offers a great amount of additional *long-term use* benefits of user adaptation (Oppermann, 1994) and "intelligent" support which are currently difficult to implement due to the episodic use of independent CAL systems (Oppermann, 1997).

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