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# Computer Supported Clinically Oriented Reasoning Exam Management System with Client/Server Architecture : CORE-Builder

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An evaluation system, COREBuilder, was developed to overcome difficulties in Clinically Oriented Reasoning Exam (CORE) and to improve the skills of students in clinical reasoning and decision making. Clinical reasoning and sufficient acquisition of theoretical and practical structure of problem solving need to be complied by the programmers developing educational software in medical training. The best learning could be carried out in the hospital with the real cases, thus, the best evaluation of the skills in clinical reasoning could also be determined at the same place. At the stage of clinical reasoning in the medical cases, frequently, there is no single right or wrong answer, and right approaches could listed from the best appropriate to the less. At this point, experience/ability in clinical reasoning becomes effective. A set up for examination involving with a classroom, chairs, tables, hiring people to oversee the exam is costly and time-consuming. This system proposes to evaluate clinical reasoning skills more efficiently than classical assessment systems.

**Keywords :** Clinical Reasoning, Computer Assisted Examination, Medical Education

## 1. Introduction

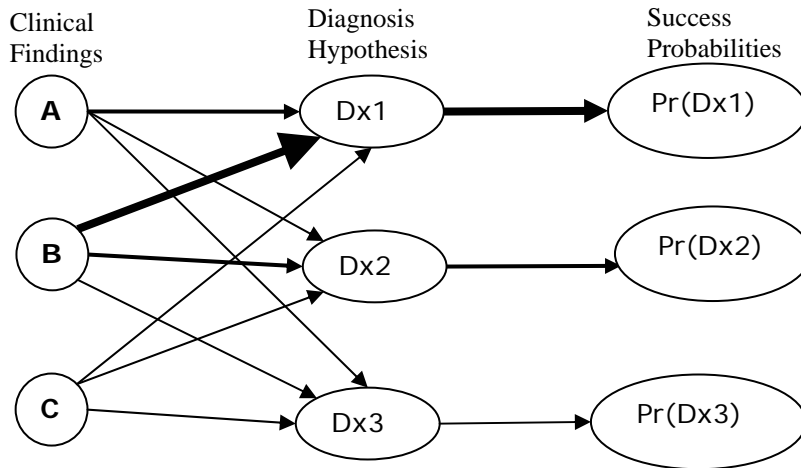
In order to solve a clinic problem, decision making process is one of the most important skills to be gained. Due to the fact that there are many factors that could effect any health problem, giving a proper decision in the lack of many data and in short time period is difficult. Recently, in medical education problem based education has started to gain popularity and it is commonly accepted that problem solving skills should be started to gain from the beginning of medical education. It is necessary that those responsible for medical education should develop their curriculum to improve clinical thinking and problem solving skills. It is believed that the best learning and examining the level of gained knowledge could be gained in the places close to the real hospital situations.

It is often encountered in the relation between patient and doctor that there is no single right or wrong. In such cases, doctors use "Clinically Oriented Reasoning Exam" (CORE) to teach cause and effect relations. There is no doubt that CORE improves reasoning skills in decision making. In this study, we propose an easier and more effective way to carry out CORE examinations.

## 2. Clinical Decision Making Process

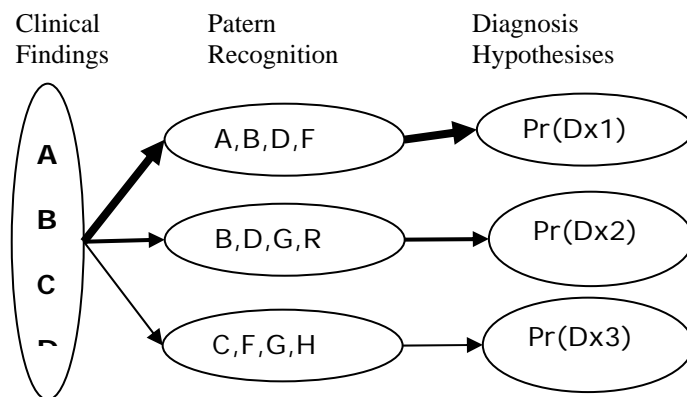
Clinical decision making can be covered by two models [1]. First is the analytical model. It is assumed that the relationship between a diagnosis and every symptom or evidence is known. Moreover, under such a profile, the probability that such a diagnosis is possible is also known.

Then, a proper treatment plan is determined by evaluating all possibilities (Fig. 1). This model often is used by inexperienced doctors.



**Fig. 1** Analytic Reasoning Model [1]

Second is the non-analytic model in that experienced doctors use subconsciously pattern recognition (Fig. 2). At first clinical reasoning is complex and difficult for a new medical doctor. Then, as more experienced gained it becomes easier and less complicated. Precision in right diagnosis increases depending on experience. However, this non-analytic method causes the major mistakes of experienced medical doctors in diagnosis[1]. The success rate increases if both models are used[1].



**Fig. 2** Non-analytic reasoning model (Pattern Recognition) [1]

### 3. Developing Clinical Reasoning Process

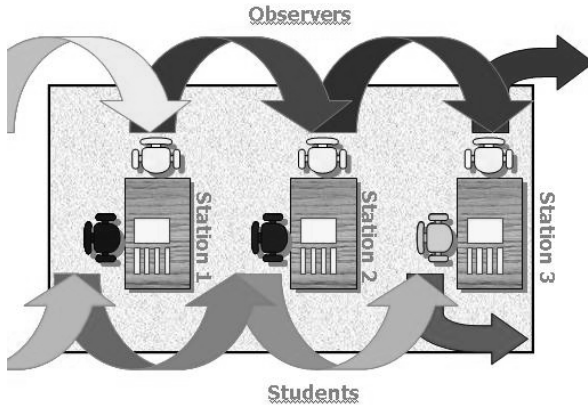
Generally, medical education takes place in two phases; pre-clinical phase and clinical phase. It is suggested that students be exposed to the activities related to develop their clinical reasoning skills after they take theoretical knowledge base [2]. Medical educators should provide necessary environment where student can develop a balanced clinical thinking skills.

For an effective measure and evaluation of the clinical thinking skills, usage of real environment conditions took place during 1990s under the name of “Clinical Problem Management” (3).

During 1970s Objectively Structured Clinical Examination (OSCE) and during 1990s CORE commonly used[4,5]. When CORE is compared to the Miller’s learning pyramid, CORE could be classified

into cause and effect group (know how)[4, 5]. The level of theoretical knowledge can be measured with well structured methods. In real situations clinical cases are generally not well structured and not anticipated by earlier developments. Therefore, students could be prepared such situations by CORE and the level of clinical thinking process also could be evaluated by CORE.

#### 4. Classical CORE Application



**Fig. 3** Classical CORE Structure

In order to apply classical CORE, an environment should be prepared as demonstrated in Fig. 3. Each table is considered as a station and a clinical case for each station is prepared in a format that student can understand. Information about the case are recorded front and back face of the cards. Student is asked to give an answer, and depending on the level of right step a negative or positive point is given to the student. When student turned the card, he gets the feedback about the question. First student and observer come to the first station, student reads the case and open cards as many as he wants. Each card opened is recorded. When finished with a station, then cards are rearranged to their original position and student and observer passes to the next station. Another student with his/her observer comes to the previous station. Completion of all station means completion of examination.

#### 5. Software Solution: COREBuilder

It is very time consuming and difficult to carry out classical CORE. To remove disadvantages of CORE and to make examination more effective, COREBuilder using Client and Server modules was developed. Those who preparing and carrying out examination is Server and the students are Client. After any kind of teaching activity, the evaluation can be carried out easily. There is no need to central database or a designated computer. Any computer, whose address is known, on the system can be used as Server. Server can be carried away and applied easily due to the fact that it carries necessary information for CORE as XML based format. As a result, more than one Client could be examined. Moreover, the package could also be used for multiple choice examinations. When used for such examination, there is only a single answer right among.



**Fig. 4** CORE Template



Fig. 5 CORE Station information

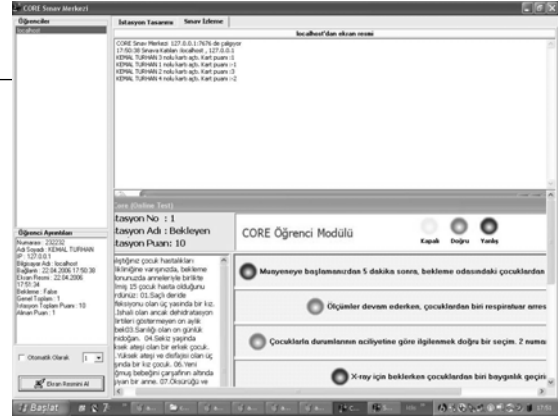


Fig. 6 Server During Examination

## 5.1. Examiner Module (Server)

The main duty of Server module, to send information belonging to that station in order, to record responses of the Client and to calculate performance of Client. Secondly, Server also carries out the design of CORE for computer environment. Number and order of stations and number of cards in each station are need to be determined (Fig. 4). According to the template, cards offer clinical thinking related to the case, responses of Client to these offers determines grading (Fig. 5). Description of the case can be supported with movie or pictures. After completion of the information, the examination could be carried out any computer laboratory.

COREBuilder can also be used to partition time to be used in each station and change station automatically depending on the time spend. The examiner can see on the Server screen the responses of each student, the points collected so far, and the picture of the student on Server screen (Fig. 6).

## 5.2. Student Module (Client)

Students are connected to the Server module with the Client module. Students in this module get exposed to the questions watch picture and films related to the cases and respond to the questions (clinical reasoning) in allowed time period by the Server (Fig. 7).

The cards not opened yet are shown in yellow, right selections are green and wrong selections are red. When a card is selected as a response, this is a permanent selection and cannot be changed with another selection. At the end of the examination student can see his/her performance on the screen (Fig. 7).

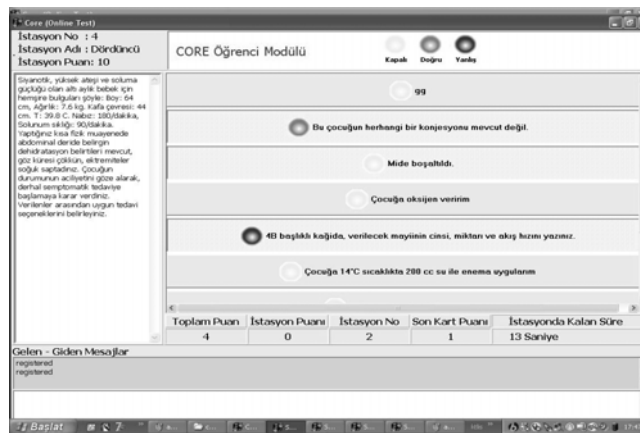


Fig. 7 Client During Examination

## 6. Discussion

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According to the Fundamental principles of medical education [6]; 1- there need to be an association between mandatory educational environment and practical working environment, 2- foundation of a system that is reliable, successful and can differentiate student depending on their knowledge, skill and attitude, 3- developing a strategy to use the latest information technology in medical education (e.g. developing advanced level computer applications).

In this study, according to the standards by the World Federation on Medical Education (WFME), an attempt to examine student in real life situation using computer technology was carried out.

In our country, there are plans that before and after medical education to determine the level of acquired knowledge and skills, examinations will be carried out. Therefore there is a growing need that more sophisticated examination systems need to be developed in order medical doctors to succeed. In abroad, there is an increasing number of web based applications supporting medical training [7, 8, 9, 10, 11, 12].

The main goals of the COREBuilder are to improve clinical thinking and to major the level of clinical thinking. In the undergoing studies, its usability and the level of its impact on current methods will be determined, as well as responses of the students to computer based examination will be measured.

## 7. Conclusion

There are three dimensions that effects each other. First, is the physical components (classroom, clinic, classroom mates, instructor etc.) that surrounds student during examination. Second is the knowledge, skill and attitudes aimed to teach students. The last is the effort to put the earlier goals together. Thus, any changes on these three components will have effects on success of learning. To be able to give necessary knowledge, skill and attitude to a candidate of medical doctor, physical conditions should be designed so that learning is permanent and motivation of the student should be optimistic all the time. Using intelligently designed computer applications can have tremendous effect on learning curve.

COREBuilder with its current structure was developed as the first step for developing skills of clinical thinking. In the second step, this program will be used not only as an examination but also as a practicing tool. The examination module is also being further developed to cover statistical analysis of all stations to be able to provide intelligent grading.

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