A Primitive Model of An Expert Training Model

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ABSTRACT

The field of Artificial Intelligence (AI) is growing, and many firms are investing in expert system, one of AI's subfields. An expert system is defined as a computer program designed to replicate some aspect of the decision making of one or more experts and to be used by nonexperts. The kernel of an expert system is the knowledge base, which consists of the facts and rules that represent the expert's knowledge. Firms need expert systems for training employees to provide competitive advantage.

This paper describes the model of an instructional expert training system which interfaces to external programs, such as an ASCII file, a worksheet program, and a database program. A model for such an expert training system, and its protoype have been developed to demonstrate its functionality. A modular knowledge base has been developed and implemented in support of this study. The modularized knowledge base offers the user an easy and quick maintenance of facts and rules, which are frequently required to change in future.

1. Introduction

1.1 Background

Many organizations face multiple problems because of the overflow of information and daily advances in new technology.

The problems include:

- double-digit turnover.
- the consequent rise in trading costs (Keyes, 1989).
- maintaining consistent expert knowledge.
- boosting productivity.
- improving the quality of performed tasks.

Keyes (1989) suggested that intelligent computer-assisted learning (ICAL), an artificial intellgence version of computer-based training (CBT), is one possible solution to the above problems. Jancura (1988) also pointed out the importance of training in the accounting profession, and suggested that such training can be effectively achieved by using intelligent computer-assisted instruction (ICAI).

In addition, Rushby (1989, p.125) emphasized the importance of intelligent tutoring systems (ITS) in the future information society by stating one case, "an ITS replaced 'plato,'the computer-based training systems that Control Data Corp recently sold."

The training of organizational personal as a means of improving productivity in highly technically-orinented industry has been an important issue. Statistics show that about 38.8 million US workers were trained for 1.2 billion hours in 1987 (Wells, 1989). The levels of training varied from the management level to the operational level (wells, 1989, Bowsher, 1989). Another survey (Manji, 1987) which addresses training in the manufacturing environment determined that 87.8% of the companies surveyed have a separate department for training engineers and production workers.

It is apparent that the training of organization personnel is important to the success of business. However, the training should fast and flexible to support the growth of individual business utits (Stein, 1989). Technology-based training is one way to fulfill such requirement.

Expert systems technology, a subset of the field of artificial intelligence (AI), involves the creation of knowledge-based systems derived from facts and rules of thumb. Expert systems have been developed for application in various fields and show great promise in others. Since an expert system can be flexible, efficient, and compatible with the human trainer, it could be the ultimate medium for fast and flexible training, which could help company personnel learn how to solve problems on their own. Bowsher (1989) and Ford (1989) predict that systems will play an important role in future education systems. In addition, Bowsher (1989, p.71) predicted the future trend of the company training method as "only companies that have implemented structured education will benifit from future advances in technology and metodology". The application of expert systems technology in education has been used in intelligent computer assisted instruction (ICAI) and intelligent tutoring systems (ITS). These terms are sometimes used as synonyms (Kearsley, 1987). Computer-based training (CBT) is a subset of CAI in aspects of using computer-based instruction (Harmon and King, 1985).

1.2 Technology of Expert Systems and ITS

In the 1980s, many organizations committed hundreds of thousands of dollars to the establishement of AI laboratories, and to the development of AI applications (Newquist III, 1990).

Most of fundamental AI techniques that have been applied are in the form of expert systems,"that is,computer systems that can help complex, real world problems in specific scientific,engineering, and medical specialities" (Barr & Feigenbaum, 1982, p.79). In fact, applications of expert systems are in various areas: science, medicine, engineering, education and training. The following goals have been pursued by expert systems researchers to emulate human behavior:

- Substitute an unavailable human expert.
- Training new experts.
- Provide requisite expertise to projects that do not attract or retain experts.
- Emulate the knowledge and exprience of several human experts.

Three main charateristics of expert systems are (Martin & Oxman, 1988):

- Performance at an expert level of competence in a particular domain.
- Databases of expert knowledge, codified and stored for use by the system's inference mechanism.
- Inference mechanism that can reason and justify their deductions.

In addition, expert systems show great promise in problem-solving activities (e.g., designing, decision-making, planning, diagnosing, etc.), although the commercailization of such products is still in its infancy (Martin and Oxman, 1988). Neverthless,the use of expert systems technology is fully recognized and growing rapidly in the information industry. The technology of AI has been applied to computer-based education environment by both educators and AI researchers, and appeared in the form of "intelligent computer assisted instruction." Today, information professions are also willing to and/or may have to adopt AI technology in training or educating personnel in their organizations.

Although the necessity and importance of an ETS have been recognized by organization (Ford, 1989), its development as a technology is in an infant stage and no successful application particular building technique, or model expert training systems appears in the literature.

In spite of several years of research and experimentation in intelligent instruction systems (IIS), the revolution of technology-based training has not materialiszed (Rushby, 1988).

Reasons for this include user misunderstanding of the advanced technology, the high cost of developing an expert training system, and immaturity of techniques for applying AI technology. In addition, selecting the right application is another critical factor for a successful expert system (Keyes, 1989; Casey, 1989).

In addition to the internal problems described above, ITS applications may need to be intergrated with another available computing resources (e.g., DBMS, worksheet, etc.) to enhance functionality.

The flood of information today forces people to use various systems available in their organizations, and often requires an integration of some systems.

For example, the integration of expert systems and database management systems could provide enhanced functionality (Howard & Daniel, 1990). Likewise, the integration of ITS with other systems(e.g., database systems, etc.), so called "external resources" in this research, may provide enriched functionality.

If ITS can communicate with external resources, especailly with powerful database systems, such ITS can contribute significantly to various information systems fields, e.g., tutoring, training, etc. In addition, the ability to share resources in systems will bring another benifit to ITS: portability. The concept of integrating ITS with other systems results in another issue that should be pursued by researchers and/or practitioners to improve the functionality of both ITS and expert training systems(ETS). For example, integration with database systems, spreadsheets, and graphics programs. Thus, some portion of this research will be dedicated to implementating an integration of an ETS with a database, which may upgrade various functions of an ETS.

2. General View of Intelligent Tutoring Systems

2.1 Introduction

In this chapter, some concept of ITS are reviewed. In addition, some existing application are examined with the purpose of determining the backbone structures, the employed methodologies and techniques of ITS. Some of those findings became a basis of developing an expert training systems model. An ITS is a computer system that contains knowledge representation formalisms. Such knowledge representation formalisms are derived from the field of AI, and exist in the form of an expert system. Thus, some notions of knowledge representation formalisms,the structure of expert systems (i.e., user interface, inference engine, and knowledge base), and the development approaches of expert system interface of expert sustems - mainly with a database system - are reviewed.

2.2 General View of Intelligent Tutoring Systems

In the early 1970s, the concept of intelligent tutoring systems was first articulated in Carbonell's paper (Carbonell, 1970). It seemed to justify the needs of adapting AI technology to ad-hoc, frame-oriented (AFO) computer Assisted Instruction (CAI) rather than defining the concepts of intelligent tutoring systems. AFO CAI went beyond conventional CAI (Barr & Feigenbaum, 1982), but the employed technique was not significantly superior to the conventional CAI.

The first stage of ITS, called "generative CAI," was quite primitive. The term was coined by Wexler (1970). Generative CAI focused on "the ability to generate problems from a large database representating the subject they taught" (Barr & Feigebaum, 1982, p.227).

In the second stage, the concept of "reactive learning environment", coined by Brown (1978), was added. The reactive learning environment provided students an active involvement in the instructional system, thus the tutorial dialogue proceeded based on student interests and misunderstandings. It is neccssary to note that Brown used concept of "tutorial dialogue", to distinguish the difference between ITS and CAI.

Koffman and Blount (1975) higtlighted the importance of recognizing a student's misconceptions. The adaption of AI technology to ITS may involve natual language understanding, knowledge representation, method of inference, etc. Applications include algebraic simplification, symbolic intergration, medical diagnosis, and theorem proving. The following systems focused on representation of the subject matter (Barr & Feigenbaum, 1982). The geography tutor SCHOLAR by Carbonell and Collins (Cabonell, 1970); the electronics troubleshooting tutor SOPHIE by Brown and Burton (1976); the logic and theory EXCHECK by suppes and his associates(Barr & Feigenbaum, 1982).

Brown (1978) and Goldstein (1977) claimed that ITS should have additional expertise including the student's learning behavior as well as tutoring strategies. When ITS include such functions, tutoring strategies could be advantages of flexiblity and modularity of representation and control.

Kearsley (1987) pointed out the paradigms of ITS application are heterogeneous, because the ITS field is still in a formative stage. He showed five different paradigms:

- Mixed-initiative dialogue: represent the original ITS paradigm, and use the Socratic method to guide the student. Example are SCHOLAR and SOPHIE. GUIDON, uses mixed-initiative dialogues, which have the prolong and structured teaching interactions that other ITS do not support.
- Coaches: observes the student's performance and guides the student to perform better. Examples are WEST, TRIP, and WUMPUS Advisor.
- Diagnostic tutors: identifies the misunderstsnding of the student during the process, and debug the problems. Example are BUGGY and PROUST.
- Microworlds: invoves a computational tool that help a student to solve a problem domain. Example is LOGO.
- Articulate expert systems: have a self decision-making ability. Although there has been no widespread use of articulate expert systems yet in training, its technique could benefit the development of applications in the training domain.

More detail on each paradigm will be examined in the following section.

Kearsley (1987) argued the development of ITS applications in the real world is very complex,because ofthe essential characteristics of ITS. According to him, the development of ITS applications should crystallize an appropriate combination of three different disciplines: computer science (AI technique), psychology (understanding student's behavior), and education and training (teaching and training methodology or philosophy). Rambally (1986, p.42) also pointed out the inherent problem of building ITS applications: "Because of size and complexity of IACI programs, no existing system has all of its components fully developed". ITS has recieved considerable attention among AI researchers, cognitive scientist , and educators. Three different disciplines (i.e., AI, cognitive science, and education) have evolved from ITS research. Thus, research goals, objectives, theories, terminology, and emphases are different between the systems. Kearsley (1987) pointed out that it is very difficult for a single discipline to solve ITS problems, which requires a mutual understanding of the three disciplines involved.

Although ITS research has been going on far more than ten years, very few ITS programs are available in a real environment , e.g., in classrooms, information centers, training centers. Rambally (1986) indicated that there is no existing system that has all components fully developed, because of the size an complexity of ITS. In addition, he pointed out "most researchers tend to focus on a single component of the system" (p.42). The component of ITS defined by Rambally are the expert module, student model module, tutorial module, and student interface module.

There are two primarily reasons for the scarcity of ITS applications. One concerns theory itself. As pointed out above, three different disciplines view ITS research in different ways, which has impeded the estabishment of a standard approach/framework for ITS. For example, Ross (1987, p.195) stated: "Public interest in the application of artificial intelligence ideas to computers used in education has blossomed, in part because of sensational but misguided publicity about AI." Another problem is insufficient hardware.

Kearsley (1987) pointed out the problems of designing successful ITS applications as:

- Paucity of ITS researchers: Quite small number of scientists (less than 100 scientists worldwide for the last ten years) are involved.
- Insufficient hardware support: Dedicated mainframes which can process complex AI programs, are available only in some university and government research laboratories.
- Complex learning procedures: Current theories of learning are not adequate for explaining how people learn.

However, the hardware problem has been resolved through significant recent improvement and innovation in hardware workstations, AI workstations, and mega-byte RAMs. The enriched capacity of computers, especially personal computers and workstations, has opened a new stage in AI research. For example, almost every organization (colleges, schools, and training centers) operate such computers. Some universities have started to offer graduate classes in ITS (Kearsley, 1987).

Ross (1987) pointed out that a major problem is a lack of a user friendly interface whth ITS. A user friendly interface is regarded currently as a critical element of building successful software for not only ITS but also Expert Systems and Database Management Systems in general. There have been considerable research efforts in NLI (Natural Language Interface, a subset of AI) to remedy or improve the user interface problems.

Ohlesson (1985) pointed out that there are problems inherent in teaching tactics and teaching strategies. These problems have also been pointed out by Kearsley (1987).

Eliot (1989) indicated that there is a controversy between AI newcomers and seasoned AI enthusiasts about the degree of adoption of visible AI techniques (i.e., heurestic technique versus induction techniques). And, Tchogovadze (1986, p.273) pointed out the reason for unsuccessful ITS applications as "AI did not yet have an adequate theoretical bases or enough supporting experience." He also pointed out two critical design problems in ITS applications. First, initial design problems are extremely complex, requiring the designer to dovote considerable time and effort to their resolution. Second, insufficient CAI design methodology currently exists to provide the application designer with a structured approach to actual ITS design.

3. Issues on Intelligent Tutoring Systems

Designing an ETS from scratch: using current programming language (e.g., C, PROLOG, LISP, etc.) is an enormous task and, thus far, there doesn't exist any such system in a complete form. The problem addressed by this research is the design of an ETS from existing building blocks (i.e., VP_Expert, dBASE III PLUS, LOTUS 1-2-3), and even more importantly, using an existing interface between these building blocks.

In addition to the above probrem, maintenance of the knowledge of ES (including ITS and ETS) is an issue critical to a successful design. The maintenance of the knowiedge depends on how a large volume of data or information can be managed efficiently. The current method of building a rule-based knowledge base system is straight forward. In other words, two components of a knowledge base, facts and rules, are stored together in a knowledge base. An ETS frequently involves a large amount of data that needs periodic updating. Whenever a small updata is necessary, a whole ETS must be reopened, and a small updata will be made. When information in a knowledge base is increased, the size of the rule base aiso should be increased in order to manage the information. This will not be a significant matter when the size of the knowledge base and the rule base are small, but, the management of a knowiedge base and a rule base can become a serious issue when their sizes are increased. How can one (instructor or trainer) who does not feel that he/she is familiar with an expert system technology, manage (modifyinging, updating, etc.) without any hesitance such a big volume of a knowledge base that is in the middle of a complicated expert system?

A major disadvantage of current ITS applications is that there is no way of identifying a trainee's learning progress after the trainee leaves the system. How can a trainer identify the trainee's progress unless someone watches the trainee working?

The major problems presented in this study thus far have included the followings:

- No model of expert training systems and successful application
- Maintenance of a knowledge base that contains a large volume of data.
- No way of keeping track of a learner's learning progress after his/her leaving the system in current ITS applications.

Therefore, the remainder of the research seeks to present solutions to those problems.

The above problems resulted in this researcher developing a model of an ETS that is loosely coupled to an external database and worksheet. In examination of the existing application of ITS in Chapter II, it was found that most existing applications consist of several modules (e.g., student module, teacher module, interface module, expert module), although none of those applications supports all four components successfully. However, these components become a basis of structuring a model of an ETS in this research.

The next chapter describes the architecture of an ETS model and its components. The tpoics include the user interface, the initialization module, the kernel module, the progress record module, the statistical report module, the lesson access module, the query module and the on-line help module.

4. Design of An ETS

To achieve the goal of developing an expert training system model loosely coupled to an external datebase and worksheet, three major issues will be addressed in this chapter as follows:

1. The development of an ETS prototype that demonstrates the capability of the proposed model, which could be of potential benefit to the traditional education environment and the industrial training environment.

2. The development and implementation of a knowledge base (expert module) that consist of two sub-modules: a rule base and a database. It could be more efficient to store a large amount of instructional data in a separate database, and design a rule base as a set of invariant rules. In this way, the rule base can be kept to a more manageable size.
   A database is a set of lessons of a defined domain (e.g., INGRES) that resides outside the main expert training system. The benefit of this mechanism is to allow an instructor or a trainer to update the materials such as lessons simply without getting involved in the main expert training system.
3. The development and implementation of a trainee's progress record module that outputs a trainee's learning process into a progress record file, which resides separately from the

main expert training system.

The system prototype, named PETS (Primitive Model of an Expert Training System) has been developed and implemented using VP_Expert, dBASE III Plus, and Lotus 1-2-3 in a PC environment. The functionality of the system is demonstrated on an exemplary problem from the domain of database management: "Creating and maintaining a database using INGRES. More datailed discussion of the implementation methodology follows in the next.

PETS is an instructive expert system that provides a trainee an opportunity to obtain knowledge of INGRES. The PETS system is capable of the following functions:

1. Diagnose a trainee's knowledge.
2. Guide a trainee to an appropriate level of domain knowledge.
3. Instruct a trainee based on the step 1 and 2.
4. Retrieve a text file for an instruction from an external database.
5. Maintain a record of a trainee's progress in a non-volatile file.
6. Allow an instructor easy access to a data-base for update.
7. Offer a friendly user interface using manu options.
8. Store a large amount of facts (sets of text data for training) in external database, and access the external databases.

A major benefit for a training program designer or an instructor in developing his/her own training program is that the PETS system requires only the replacement of the set of questions and instructional material stored in external database files (e.g., lessons, slides, etc.) unless he/she wants to change a training strategy. Since the external database files are indenpent from the main system, the update or replacement of the external database is simple. For example, a set of questions are stored in the external database (dBASE III Plus file). These questions are used for diagnosing a trainee's knowledge level. To modify or update the questions in the external database, the required process is as follows:

1. Run dBASE III Plus program.
2. Open a file (e.g., "question.dbf") that contains a set of questions.
3. Update or modify the questions stored in question.dbf.
4. Close the file question.dbf and save it.
5. Exit dBASE III Plus.

In addition, a training program developer can also enter new instructional text (e.g., lessons) in an external database (e.g., ASCII files) or can update the lessons when necessary. The necessary procedure is as follows:

1. Select an ASCII word procesor (e.g., edlin, etc.).
2. Create an ASCII file (e.g., "lesson.txt") which has an extention "txt." If a file already exists and needs an update, open an ASCII file using a new processor.
3. Perform necessary task (e.g., update, modification, create a new file, etc.).
4. Close and save the ASCII file lesson.txt.
5. Exit the word processor.

Thus, a training program developer can replace the current training instructions (e.g., lessons, questions) by new training instructions in a reasonable time period without any major difficulty. A training program developer could use a scanner to read text instructions into the external database. In doing so, he/she could reduce the database development time signficantly.

In addition, the PETS system does not require any complicated AI knowledge for changing, modifying, or updating instruction materials stored in an external database. This provides users (e.g., training program developers) a user-friendly system.

However, it may require the training program developer to have knowledge of the PETS system in order to modify the training strategy which is embedded in the rules. These rules are written in the system shell of VP_Expert. Thus, a training program developer may also need to be familiar which the use of VP_Expert to do advanced work such as modifying the source code.

Seen from a high conceptual level, PETS can be regarded as having four major components that effect interfacing to external systems. These components are (Figure 1):

1) Main system.
2) dBASE III Plus file (external system).
3) LOTUS 1-2-3 (external system).
4) ASCII file (external system).

Main system

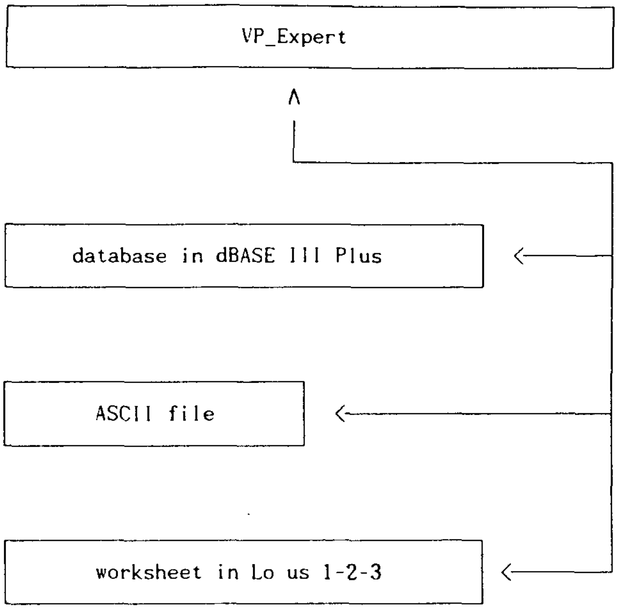


Figure 1 The Basic Architecture of the PETS System

The main system consists of eight modules as follows:

1) The user interface module.
2) The initialization module.
3) The Kernel (diagnostic procedures).
4) The progress record module.
5) The statistical report module.
6) The lesson access module.
7) The queries module.
8) The on-line help module.

One module, the Kernel, also contains the modules that implement the intelligent instruction system. They are:

a) The training module.
b) The trainee model module.
c) The expert module.

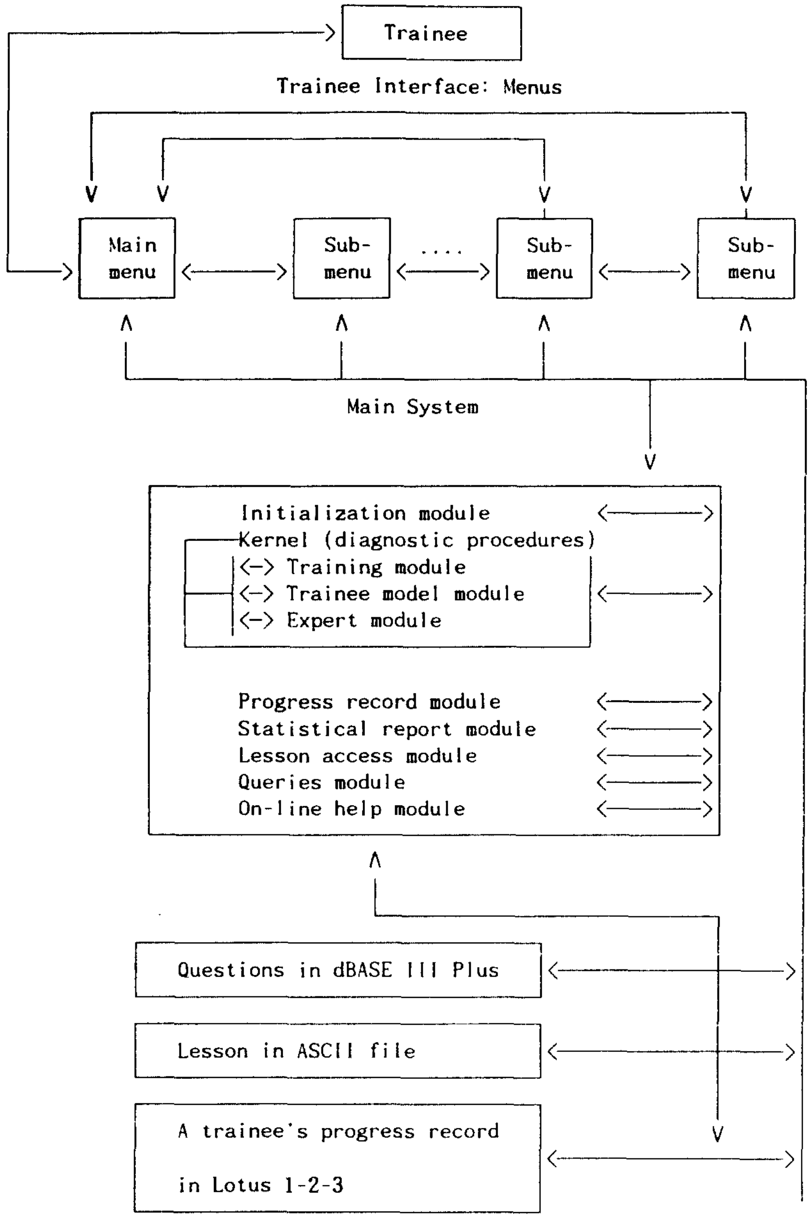


Figure 2 The Final Architecture of PETS

4.1 The User Interface

This modules provides a friendly interface to a trainee. Two types of communication methods are emploed: 1) a question and answer format, and 2) a menu driven mechanism (Figure 2).

These two different types of communication will be used approapriately in the PETS system, depending on trainee requests and what the trainee is currently doing (or trying to do). For example, first, a trainee can select any preferred level of tasks via the "menu" system: and second, a trainee can interact with an expert system by dialogue "question and answer format". The menu of the PETS system is organized in the form of hierachy.

4.2. The Kernel(Diagnostic Procedures)

This set of modules is an inference engine within the PETS system, that acts as a main controller for entire system. Some components of intelligent instruction systems are integrated into the Kernel. They are 1) training module, 2) trainee model module, 3) expert module.

4.2.1 The Training module

As an expert training system, the PETS system is concerned with the following four issues:

1. Communciate with a trainee.
2. Select problems for a trainee to solve.
3. Analyze a trainee's performance.
4. Select and provide appropriate instructions such as lessons.

The training module is a group of "if-then" rules and facts which preformed the related tasks as listed above. Most rules in the training module are concerned with analyzing the trainee's understanding of the subject and selecting the problems that correspond to the analysis. The training rules aim to actieve the essential instructional objectives of the PETS system.

The training rules are concerned with the following:

1. Select problems for a trainee to solve.
2. Respond to partial solutions.
3. Guide direction of domain rules.
4. Complete discussion of a topic.
5. Maintain communication with other modules and the trainee.

Some of three function (rules and facts) may be summoned by some other module. The training module, however, is the one that provides the most communication with the trainee. This is effected either directly or through a trainee interface.

4.2.2. The Expert Module

給與基準을 잘못 적용하거나 수납누락되는 것을 포함하면 손실율은 더 커지리라 생각된다.

세째, 등록 및 수납 후 일정한 순서의 진료행위에 대한 안내가 없고 이에 따라 환자의 병원내에서의 체제시간이 길어 환자들의 종합병원 진료기피 요인중의 하나가 되고 있다.

네째, 병원내 각 부서들은 환자의 흐름과 정보의 흐름으로 상호같은 관련을 가지고 있기 때문에 현재와 같은 Off Line 과 같은 기능으로서는 진료받기 위한 환자의 대기시간을 줄일 수 없는 문제점이 있다.

다섯째, 현재 병원에서 근무하는 전문적인 간호사 및 간호조무사들은 환자에 대한 차트기록과 환자간호, 병동관리 등에 전문적인 직무를 수행함에도 불구하고 간호사들은 환자급식, 환자배치, 물품수령, 검사결과수령 및 기록, 매일 발행되는 각종 처방등의 운반.정리에 많은 시간과 인력을 소모하고 간호사 본연의 임무는 8시간 중 2-3시간에 그칠 때가 많다.

여섯째, 검사기록의 중복과 검사결과의 신속성 결여에 따른 입원기간 길어질 수 가 있다. 이로인해 병상관리상 병상회전율이 떨어져 병원의 진료수입에 감소를 가져올 수 있다. 즉 이런 경우는 장기입원(다른 처치들은 끝나고 검사결과 때문에 퇴원이 늦어지는 경우)으로 병원으로서는 병상회전율이 낮아지고 입원대기환자의 적체요인이 될 수 있다.

일곱째, 병원에서 환자에 대한 많은 진료정보가 발생하고 있고 이를 기초의학면이나 조사통계자료, 진료기록등의 활용가치 높은 자료들이 사장되거나 이용에 어려움이 있다.

여덟째, 현재 외래 및 병실과 수납 및 진료지원부서의 On-line化가 안된 상태에서는 진료지원부서에서 검사한 품목과 외래 및 병실에서 처방한 내용 및 외래.병실수납금액간의 일치여부를 확인할 수 없다.

아홉째, 의료보험 및 기타 미수금관리, 진료품목별 원가분석 등의 不在에 따른 병원 경영분석에 취약성이 있다.

5. 問題點에 對한 原因分析

Y 병원 HMIS는 환자등록, 진료비 산정, 보험청구 및 심사를 중심으로 구축되어 효과를 보고 있으나 외래환자에 대한 진료동선의 불합리 및 투약대기시간이 길어진다거나 진료부서와 진료지원부서간의 처방전달의 정확성 및 신속성 결여등 외래 및 병동업무와 진료지원부서에서 HMIS의 주요 문제점에 대한 원인은 다음과 같다.

(1) 환자등록 및 수납으로 인한 환자의 병원내 체체시간 및 진료동선이 길어지고 있는 원인은 다음과 같다.

첫째, 현재 환자등록시 이용되는 등록카드는 환자성명, 성별, 주민등록번호를 등록 담당자가 확인 후 수작업 입력에 의해 환자인적사항 등을 조회할 수 있는 單純한 기능을 하고 있으며, 등록시 초진은 환자 1명당 2-3분, 재진은 환자 1명당 1-2분이 소요되어 초.재진 등록시 10-20분 기다리는 경우가 많고 특별한 진료과에서는 1시간 이상 기다려야 당일접수가 가능하다.

둘째, 1,2층에 분산된 외래진료과에서 진료후 각종 처방전에 대한 진료비를 계산하기 위하여 일원화된 수납창구(등록 및 외래수납이 각각 기능이 분리되어 1층에 집중되어 있음)에서 수납하므로 일정한 시간에 재진환자가 70% 이상 차지하는 병원에서 등록하는데 장시간의 대기시간을 필요로 하고 있어 등록 및 외래수납창구의 구조는 분산배치 및 환자와 대화로서 원활한 업무처리에 도움을 줄 수 있는 구조로 할 필요가 있다.

(2) 외래환자들의 처방전 분실 및 수납누락의 원인으로는 외래진료후 일정한 진료순서에 대한 정확한 안내가 부족하여 환자들은 각종검사에 대한 처방전을 수납하지 않고 진료지원부서에 검사예약 및 처치를 받는 경우가 있고 또 일정한 진료행위에 대한 인식부족으로 병원내에서의 체제시간이 길어지고 있어 환자들의 종합병원 診療忌避 요인이 되고 있다.

(3) 외래환자들에 대한 투약대기시간이 길어지는 원인으로는 투약제조시 한정된 외래약사들이 봉투에 적게되는 환자이름, 투약내용, 복용법등을 일일이 손으로 적는 업무와 투약처방 업무흐름이 Off line으로 인해 외래약국에서의 투약대기시간은 더욱 길어지고 있다.

(4) 병동근무자들에 대한 처방전 운반 및 결과지 정리등의 인력소모는 현

The on-line help facility should not only display simple text instructions but also guide a user to relevant areas. For example, the system should be able to help a trainee who wants to preview a certain lesson, but does not remember or know the lesson number. In this case, most trainee will be frustrated about how to reach to that point.

To avoid the above problem, the PETS system is able to guide a trainee to the area he/she wants to reach. Thus, a trainee can access a particular lesson or question for either preview or review.

Consequently, this on-line help module cooperates with the modules of "Lesson Access" and "Queries" to make a system more user friendly so that a trainee would not feel uncomfortable during the PETS system training session.

5. Implimentation and Results

PETS has been designed for interactive use by human trainers and trainees. The key elements of the system design are as follows:

a) The integration of the main system (VP_Expert) with exteral database (dBASE III plus, LOTUS 1-2-3, ASCII file), which constructs a knowledge base of the PETS system.

b) The trainee progress record module, which have been designed to take advantage of the power of the system interface of the expert system shell: VP_Expert.

c) A menu-driven friendly user interface that provides a trainee a versatile functions, and allow a trainee flexible movements in a non-linear fashion.

A prototype of the PETS system, was implemented using the VP_Expert, dBASE III Plus, and Lotus 1-2-3 on a PC to demonstrate the functionality of the proposed model of an expert training system.

The implementation focused on the integration of the rule base (expert module) in the main system with external programs such as a database file in dBASE III Plus, and worksheet in Lotus 1-2-3. The database of the defined domain is open, inthe sense that the trainer can always access such database as dBASE III Plus, LOTUS 1-2-3, ASCII files to modify and update the contents which constitute the knowledge in the system.

The PETS system consists of four major components that interface to external database and the worksheet systems.

The major componets are :

1) Main system

2) dBASE III Plus file

3) LOTUS 1-2-3 file

4) ASCII file

The main sysyem consists of eight submodules as follows:

1) The user interface module (Menus)

2) The initialization module

3) The kernel (diagnostic procedures)

4) The progress record module

5) The statistical report module

6) The lesson access module

7) The queries module

8) The on-line help module

Kernel is composed of essential of intelligent instruction systems. They are:

1) The training module.

2) The trainee model module.

3) The expert module.

The large knowledge base of the PETS system system is comprised of three external systems that, in turn, make of the storage mechanism. They are:

1. dBASE III Plus file.
2. LOTUS 1-2-3 file.
3. ASCII file.

In more detail,

1. The dBASE III Plus file contains a set of questions that are used for diagnosing a trainee's knowledge level duringa training (consultation) session.
2. The LOTUS 1-2-3 file contains a record of a trainee's progress during a training session. In other words, it contains a record of every interaction that was executed between a trainee and the PETS system during a training session.
3. The ASCII file is a set of text instruction materials. It could be comprised of a series of slides or lessons. These lessons or slides are automatically retrieved and displayed on the screen to instruct a trainee when necessary.

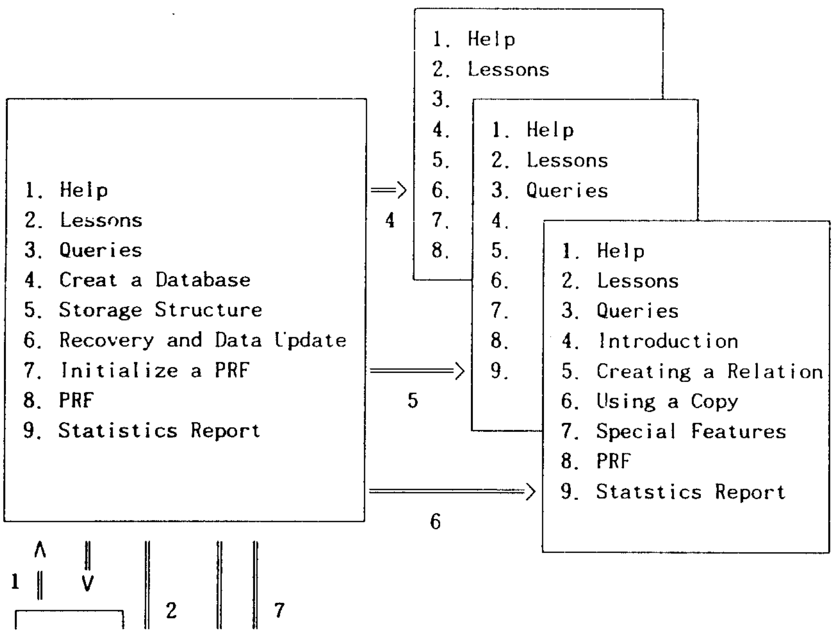
The sysyem begins with identifying the trainee's name and date for tracking his/her progress record. The system provides a couple of modules so that both the trainer and trainee can review how the trainee proceeds during the training. The modules are progress record file (PRF) and Statistical Report. Optionally, the trainee can study the necessary part(s) of the subject in the following instances:

1. after reviewing what he/shehas done during the training.
2. without following the system's diagnosis procedure, if he/she know which lesson(s) need to be learned. Thes will be the case if the trainee has used the sysyem before and he/she rememvers the point where he/she left.

The PETS system includes a question-answer, mixed-initiative training strategy employed, which is performed via the provided menu options. Even during the procedure of the system's diagnosis, the trainee can obtain some concepts through the multiple choices by identifying his/her misconceptions about the subject. More detailed discussions follows in the subsequent sections.

5.1 The Trainee Interface

The main system offers menus that provide a friendly user interface. A trainee communicates with the system bidirectionally, via a menu interface. The system starts with a main menu which consists of submenus that contain numerous queries for constructing the reasoning process . The system generates sequential responses based on the trainec's choices (Figure 3).



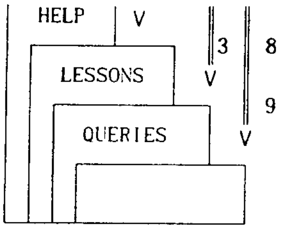


Figure 3 The structured Menus of PETS

5.2 The Kernel

This set of modules provides main control of the entire PETS system. Three components (training, trainee model, expert module) of the intelligent instruction systems are integrated into the kernel, and embedded into the rules of the procedures for diagnosing a trainee's knowledge level.

The kernel is responsible for the following:

1. Communicate with a trainee.
2. Select problems for a trainee to solve.
3. Respond to partial solutions.
4. Analyze a trainee's performance.
5. Guide direction of domain rules.
6. Select and provide appropreate instructions such as lessons.
7. Complete discussion of a topic .
8. Maintain communication with other modules and a trainee.

Some important tasks (e.g., retrieving lessons, recording a trainee's progress, etc.) are performed based on the close interactions with the external databases such as

1. a set of questions in dBASE III Plus file,
2. a set of lessons in ASCII file,
3. a record of a trainee's learning progress.

The training module bases its reasoning process on building contexts as a set of quiries and uses them to match suitable answers from its trainee-spcific rule base. The training module will operate this reasoning process in the beginning of the execution in order to identify a trainee's knowledge level. In addition, a trainee will be able to return to thes procedure whenever he/she desires to evaluate his/her knowledge or to begin from another level.

The knowledge base of the PETS system is comprised of two parts: internal rule base and external data base as shown in Figure 4.

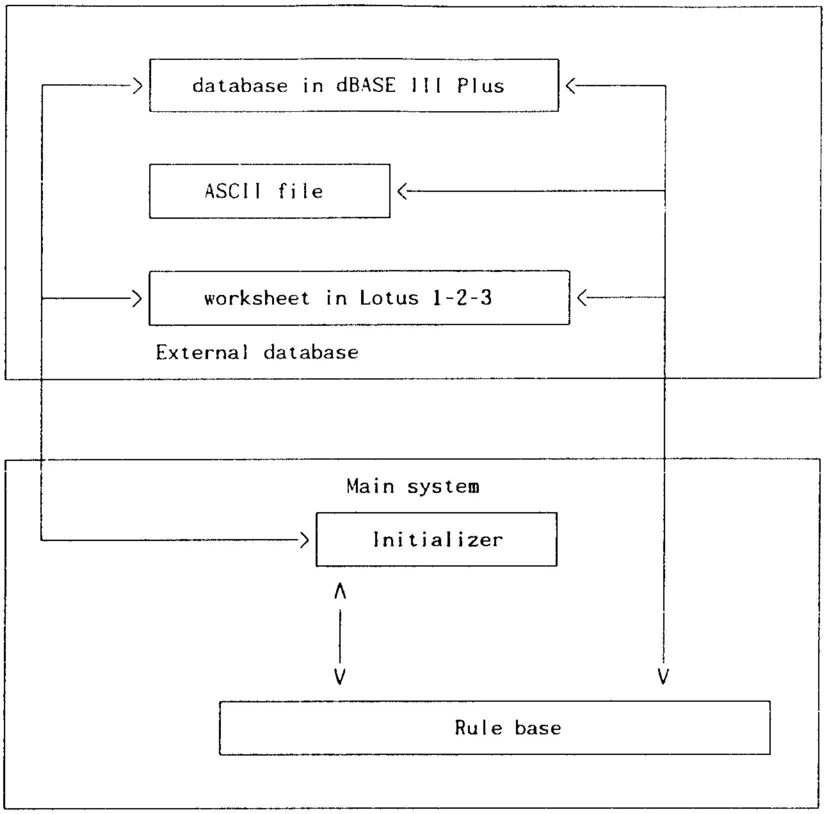


Figure 4 The Skeleton of The Knowledge Base of PETS

5.3 The Progress Record File (PRF)

PRF is an external data base file that is independent from the main system. This file contains the record of interaction between a trainee and the system, and it is a non-volatile file. This file is created by using LOTUS 1-2-3. The internal work of the progress record module is twofold as follows:

1. System's action (e.g., query)
    1) Open a PRF (LOTUS 1-2-3 file, named as "young.wks" in the PETS system.).
    2) Find an appropriate location on the PRF to be recorded.

Finding an appropriate location is important because the order of the recorded information reflects a trainee's progress.

3) Write data in the found location.
4) Close the PRF.

2. Trainee's response
   1) Open a PRF (LOTUS 1-2-3 file, named as "young.wks" in the PETS system.).
   2) Find appropriate location on the PRF to be recorded. Finding an appropriate location is important because the order of the recorded information reflects a trainee's progress. In addition, the trainee's response may require several different types of the records to be tracted.
   3) Write data in the found location.
   4) Close the PRF.

The above actions need to be done for every interaction between a trainee and the system. A worksheet file is formatted with row heading and column heading. In this system, VP_Expert (VPX) accesses worksheet cells by using a parameter which is a VPX variable that has been assigned a value corresponding to a worksheet row heading, or column heading, or range name. A parameter can be a worksheet heading name directly.

In this case, VPX accesses the cells through column headings either directly or indirectly, depending on the context of situations within the main program. Accordingly, the recording of every interaction between a trainee and the system tasks a lot of computer memory space which can cause a system to crash unpredictably. In addition, it also may cause recursion at an exceedingly deep level, beyond the capacity of the implementation tool. As a result, the VPX system will cease functioning.

The worksheet in this system represents a trainee's progress record file. A part of the worksheet is shown in Figure 5. The worksheet columns hold index numbers, question numbers, answers, validation of answers, lessons, queries numbers, extra lessons, first and last name of trainee, and data.

no	menus	questions	answers	validity

1	4	1	3	-1
2	4	2	4	1
3	0			
4	0			

lessons	queries	xtrlesson	name	data
100	35	101	young	
101	0	0	yoo	
0	0	0		9-27-90
0	0	0		

Figure 5 A Sample of the PRF

5.4 Summary

The PETS system has been developed in order to demonstrate the functionality of the proposed expert training system model with the emphasis on implementation of the interactions on the heterogeneous systems in this research. The results show how the system can be used to share the benefits of other system's mature technology. The PETS system allows a trainer to identify a trainee's progress, the results of his/her progress, and access to the external database for the maintenance in a convenient way.

In addition, the modularized knowledge base of the system allows a knowledge engineer to update and modify the rule base easily, quickly, and conveniently. Development of a fully functional expert training system, based on the concepts proposed in this study, would require substantial additional research and development efforts, dealing with search space issues, other implementation issues as well as substantial improvement and additions to the (defined domain) knowledge base.

6. Conclusion

6.1 Conclusions

The goal of this study has been to develop an expert training system model, to develop and implement its knowledge base that is loosely coupled to the external programs, and to develop and implement a trainee's progress record module.

The primary contribution of this research is the design of a knowledge base (expert module) that consists of an external database and a rule base, and trainee progress record module for an expert trianing system model.

The approach developed here integrates external ststems, such as a database system, to an expert system. Therefore, the approach developed here focused on 1) the development and implementation of the interactions between the heterogeneous systems and 2) the development and implementation of the system that supports a trainee's progress record.

The PETS system has been implemented in order to test the proposed expert training system model discussed in the research. The PETS system is an experimental prototype designed to demonstrate the functionality of the system. The emphasis has been on the development and implementation of a knowledge base that has a separate database and a rule base, and a progress record file that keeps track of the trainee's learning progress during a training session. A PRF is a non-volatile file even after a trainee leaves the system.

As an implementation technique, modularization has been employed to implement the PETS system in the restricted environment regarding both hardware and software. The modularization approach has addressed of the problems of search space and reduction of recursion levels.

Consequently, the knowledge base has been modularized into several parts, which has resulted in both advantages and disadvantages.

The major advantages include:

- Easy identification of the location of specific rules or facts.
- Easy access, modification, and update of necessary rules or facts.
- Rapid implementation by reducing the compilation process of a whole system.
- Virtually, unlimited number of properly modularized sizes of knowledge bases.

In addition, it also provides a rapid and convenient way of maintaining the data stored in the external database. The modularization and separate database have shown a possibility of building a portable knowledge base.

The major disadvantage of the PETS system is that the modularized knowledge bases slows down the system performance. Thus, the trainee might not be able to accomplish work in a timely fashion. That could be significant for slow speed computers.

Another problem found during implementation was in keeping track of the close interactions between the main system and the external systems with the purpose of recording these interactions on the PRF. Interface to an external worksheet file:

- takes a significant amount memory space and time consequently
- causes very deep levels of recursion.

This can cause an interaction time delay and a system crash (due to the out of memory error) unpredictably. The problem is twofold. One is the limited capacity of both hardware and software being used for the implementation. Another one is due to the complexity of the main system that has to trace every interaction between the system and trainee in order to record ordered interactions on the PRF.

6.2 Future Research

Suggestions for future areas related to the work presented in this research, are in several areas.

Formal proof of efficiency and soundness for the proposed expert training system model developed in this research is beyond the scope of this study. The formal structure and frame of PETS is a foundation for further work in this area.

The PET system, as with most expert systems, does not support a graphical user interface. This is due to the limited functionality of the implementation tool. However, the graphical user interface (GUI) offers a better user interface than character-based user interface (CUI). GUI can help a user:

- to work faster and better
- to have higher productivity than CUI users
- to learn more capabilities within applications.

Simulation techniques could be integrated into an expert training system in order to enhance the degree of domain training. For example, the military has used CAI for many years, particularly flight and maintenance simulations. The combination of expert system and simulation techniques could contribute to future training environments, especially when GUI's are fully supported.

One of the major disadvantages of the PETS system is the lack of natural language interface (NLI). The PETS system uses a "question-answer" dialog, based on menu selection. The use of menu selection was intended to make up for the lack of GUI and NLI to some extent. For example, the PETS system allows a trainee to initialize a PRF through the provided menu options. Still AI researchers have continued to improve NLI techniques over the past years. NLI is also important in ETS because it allows the trainee to take the initiative and ask questions that were not anticipated by the system.

Accordingly, it is desirable that a trainee be provided with a convenient way to communicate his/her ideas to the system, rather than merely following the system's instructions. Regardless of implementation languages or tools, future expert training systems are expected to support NLI, and provide trainees with a more convenient way to communicate with the system.

It is hoped that this study paves the way for further studies that will address the additional solutions to the difficulties described in this article.

REFERENCES

Barr, A & Feigenbaum E. (1982). The Handbook of Artificial Intelligence. CA: William Kaufmann.

Bowsher, J. E. (1989). Five phases for managing change in education. Training & Development Journal, 43(6), 71-75.

Brown, J. S. & Burton, R. (1978). Diagnostic models for procedural bugs in basic mathematical skills. Cognitive Science, 2, pp. 155-192.

Burton, R. & Brown, J. S. (1976). A tutoring and student modeling paradigm for gaming environments. SIGCSE Bulletin, 8, pp. 236-246.

Carbonell, J. R. (1970). AI in CAI: An artificial intelligence approach to computer-aided instruction. IEEE-Transactions on Man-Machine Systems MMS, 11(4), pp. 190-202.

Casey, J. (1989). Picking the right expert system application. AI-EXPERT, 4(9), pp. 44-47.

Eliot, L. B. (1989, Summer). CAIA 1989: AI Applications. IEEE-EXPERT, 4(2), 78-79.

Ford, R. C. (1989). Tapping into expert systems. Personnel Administrator, 34(1), 26-32.

Goldstein, I. P. (1978). The genetic epistemology of rule systems (Memo No. 449). MIT A.I. Laboratory.

Harmon, P. & King, D. (1985). Artificial Intelligence in Business. NY: John Wiley & Sons.

Howard, H. C. & Daniel, R. R. (Fall, 1990). KADBASE: Interfacing expert systems with databases. IEEE-EXPERT, 4(3), 65-76.

Jancura, E. G. (1988). Expert systems in training. Woman CPA, 50(1), 16-19.

Kearsley, G. (1987). Artificial Intelligent and Instruction: Applications and Methods. New York: Addison-Wesley.

Keyes, J. (1989). Why expert systems fail. AI-EXPERT, 4(11), PP. 50-53.

Manji, J. E. (1987). Preparing for CIM: Is your training sufficient? Automation, 34(11), 24-26.

Martin, J. & Oxman, S. (1988). Building Expert Systems: A Tutorial. NJ: Prentice-Hall, Englewood Cliffs.

Newquist Ⅲ, H. P. (1990). The AI eithtics. AI-Expert, 5(1), 61-69.

Rambally, G. K. (1986). The AI approach to CAI. The Computing Teacher, April, pp. 39-42.

Ross, P. (1987). Intelligent tutoring systems. Journal of Computer Assisted Learning, 3(4), 194-203.

Rushby, N. (1988). Do we really need intelligent teaching systems? Personnel Mgmt (UK), 20(3), 53. (From ABI/INFORM Abstract, January 1985 - December 1989, Abstract No. 88-19448).

Stein, J. (1989, June 5). An author's ACE in the hole? Computerworld, 23(23), p. 1.

Tchogovadaze, G. G. (1986). Some steps towards intelligent computer tutoring systems. Education & Computing, 2, 273-277.

Wells, R. A. (1989). A review of educational technology for management development. Journal of Management Development (UK), 8(2), 33-40. (From ABI/INFORM Abstract, January 1985 - December 1989, Abstract No. 89-40768).

Wexler, J. D. (1970). Information networks in generative computer-based instruction. IEEE Transactions on Man-Machine Systems MMS, 11, pp. 181-190.