AN APPLICATION ON KNOWLEDGE ENGINEERING IN EDUCATION

Jerinic Ljubomir
Institute of Mathematics
Trg Dositeja Obradovica 4
21000 Novi Sad, Yugoslavia

Phone: +21-58-588
e-mail: jerinic@unsim.yubgef51.bitnet
Fax: +21 350 458

ABSTRACT

In the Institute of Mathematics, University of Novi Sad, a general purpose educational software EduSof, has been recently developed [Je92]. Its basic elements enable the process of creating and using educational sequences and testing of the acquired knowledge. The first version of EduSof, called OSOF [Je88, Je89, Je90, Bu89], assumed the lessons are presented as a sequence of pages of a text. However, the diversity of educational process requires that general purpose educational software must include graphics and simulations as the information [Bu90, Pu90].

In this article, a theoretical approach to the definition and realization of EduSof and a brief description of the usage of EduSof is presented. Also, an account is given of further research directions on producing an intelligent system for creating and using the knowledge in education based on the methods of knowledge engineering.

1. INTRODUCTION

According to E. Feigebaum [BaFe80, BuFe78], Artificial Intelligence (AI) is the part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit the characteristics we associate with intelligence in human behavior - understanding language, learning, reasoning, solving problems and so on. AI is a science discipline which has its roots in the field of symbolic computing and cognitive science.

AI examines [Wi77] symbolic (non - numerical) and heuristic (non -algorithmic) processes of computer conclusions and computer reasoning, as well as a suitable knowledge representation for computer inference. The main parts of AI are Natural Language Understanding, Machine Learning, Automatic Programming, Computer Vision, Intelligent Robotics, Knowledge Engineering, etc.

Rapid development of computer technologies and AI methods, introduction of computers into schools, as well as widespread use of computers by people of different vocation and age, made AI become a field of ever - increasing important to education researches. The development of knowledge engineering, by its definition, methods and results becomes also directly applicable in education, whose goal is complete individualization of the educational process.

The paper describes one of the possible and convenient ways of representing knowledge in educational processes, based on the frame concept [Ni80], which is used for realization of the EduSof system, the system for generating lessons in almost all teaching subjects. On the basis of testing of the system, it has been concluded that it is especially suitable for different models of use in:

- mastering the subject and acquiring knowledge,
- testing the acquired knowledge,
- different other ways of knowledge testing, etc.
The **EduSof** programming system based upon such a way of presenting and representing, is implemented in the part of internal knowledge representation, knowledge acquisition and creation of lessons by the teacher, and the use for programmed learning and knowledge acquiring. The implementation has been carried out on IBM PC compatible computers under MS DOS operating system.

2. **KNOWLEDGE ENGINEERING AND ITS APPLICATION IN EDUCATION**

The programming system in knowledge engineering consists of represented knowledge (knowledge base) and reasoning mechanism (inference engine). The process of construction of a system in knowledge engineering in education must contain the following five topics [CI83, Ja86]:

a. **Knowledge Acquisition**, acquisition and systematization of relevant knowledge, or machine learning on examples.

b. **Knowledge Representation**, selection of an appropriate way by which a great amount of knowledge can be presented in the form of symbolic structures within the computer, suitable for deriving conclusions. The structure chosen should enable flexible alterations and supplementing of the knowledge stored.

c. **Knowledge Application**, planning and control of the problem solving, heuristic deriving of conclusions, accuracy and efficiency of intelligent processes.

d. **Explanation Generation**, interaction computer - pupil, explanation why a particular problem has been solved in a way and not in another, possibility of learning on errors, and the influence of the user on processes of conclusion.

e. **Education**, the acquired knowledge can also be used for producing intelligent systems for teaching the user (pupil or teacher) how to use them, as well in the education of the beginners or future experts.

Computers can be used in educational process as a teaching aid, completely different from any other known teaching means. Specific thing about computers is that direct communication computer - pupil is possible. That means that the computer is able to answer various questions of a pupil, leading him through process of learning, to improve pupil’s independence in learning, to individualize teaching process, to advance through lessons depending of pupil's ability, etc.

As a condition for computer application in education, we assume the existence of high quality education software, based on teaching methods, didactic and pedagogy principles. Education software can be classified as follows [Je90]:

- **Specialized educational software** developed for unique fields (mathematics, chemistry, physics, etc.). They are highly specialized, rarely useful in general purpose, their development is time consuming and expensive.

- **General purpose educational software**, which represents some tools for preparing and using knowledge in educational process, in all fields. Because of its generality, this kind of software must be able to accept various sorts of knowledge representation.
Educational software EduSof, developed in the Institute of Mathematics, University of Novi Sad, is general purpose educational software. As EduSof is intended to be qualitative, universal, and widely used tool for using in educational process, need for various way of representing knowledge appear. In EduSof knowledge can be:

- some of textual information or knowledge represented by the means of text, and/or
- pictures (graphic representation of knowledge), as almost obligatory element of all educational sequences, especially in the field of natural sciences, and/or
- simulations, because, in various fields experiments must be a part of educational process, so there is a need for some simulation ability as a part of representing knowledge.

3. BASIC CONCEPT OF EduSof

EduSof, which is natural extension of OSOF [Je88, Je89, Je90, Bu89, Bu90, Pu90], consists of three subsystems:

1) **Teacher**, subsystem used for creating educational sequence, input of all necessary knowledge for each notation and for creation of lesson structure and relations between notations.
2) **Learn**, subsystem used for learning and using lessons by the pupil, which are created with the aid of Teach module.
3) **Examine**, subsystem used for testing knowledge acquired by using Learn module.
In OSOF [Je80, Je90] data structure used in lessons were organized as a list of *notions*. Notions can be expressed by the means of *text*, *picture*, and/or *simulation*. For each notion, a list of assignment is given. For each assignment, a list of alternatives is given, as possible answers to that assignment. For each alternative, the right answer is provided, and also the information about the "flow" of the lesson, in case that right answer is chosen. So, data structure can be represented\(^1\) as follows:

```
Begin Sequence
    { Name : String;
      F Start : Notion }
End;

Begin Notion
    { Subject : String;
      Description : String, Simulation, Picture;
      F Question : Assignment }
End;

Begin Assignment
    { Description : String, Simulation, Picture;
      F Next : Assignment;
      F Answer : Alternative }
End;

Begin Alternative
    { Description : (Selection; Open answer; Pairing);
      F Action : (Notion; Assignment; More description; End_Of_Lesson)
      F Next : Alternative }
```

\(^1\)The notation similar the notation proposed in [Fr86] was used.
In Figures 1, 2 and 3 are presented the general schemes of representing knowledge in OSOF system, based on knowledge representation described above.

In above definition, we used the concept of Frames, (marked with F), for knowledge representations. In frames Sequence, Notation, Assignment and End_Of_Lesson, String indicates a text of an arbitrary length, Simulation symbolizes a program for simulating some process, and Picture signifies arbitrary graphics. In the frame Alternative, the possible things that pupil should do can be Selection, choosing alternative given for that assignment, Open answer entering the right answer, later analyzed by teacher, or Pairing, i.e. solving a problem by pairing right alternatives from two sets of answers. Depending on the pupil's answer, computer's action will be choosing one of the frames: Notion, Assignment or End_Of_Lesson, or a set of frames Notion, which will give more explanations on the problem - More description. The sign F before a name of a slot indicate that its value is a pointer to a frame.

In EduSof, a teaching sequence is organized as a list of semantically connected elements - Lessons. They are consists of a list of Concepts. Concepts, as basic components of a teaching sequence, can be expressed by the means of Text, Picture, and/or Simulation.

For each Concept, lists of Questions are given, used for testing acquired knowledge connected to that Concept. For each Question, a list of Alternatives is given, as possible answers to that question, or the right Answer. For each Alternative, the Right Answer is provided. Also the information about What Next, in cases that right or wrong answer is chosen. So, data structure used in EduSof can be represented as follows:
Figure 4 Organization of EduSof system

Lesson
    Name : Text;
    Frame Start : Concept;
EndLesson.

Concept
    Name : Text;
    Characterization : (Text ∨ Simulation ∨ Picture);
    Frame Query : Question;
    Frame Response : Answer;
    Frame Explanation : Concept;
    Frame WhatNext : (Concept ∨ Lesson ∨ EndLearning);
    Frame Conclusion : Inference;
EndConcept;

Question
    Characterization : (Text ∨ Simulation ∨ Picture);
    Frame Query : Question;
    Frame Response : Answer;
    Frame Explanation : Concept;
    Frame WhatNext : (Concept ∨ Lesson ∨ EndLearning ∨ Alternative);
    Frame Conclusion : Inference;
EndQuestion;

Alternative
    Characterization : (Text ∨ Simulation ∨ Picture);
    Examine : (Selection ∨ OpenAnswer ∨ Pairing ∨ ...);
4. USAGE OF EduSof

In this section we shall give first a graphic representation of the method described above for presentation of the knowledge introduced by the Teacher module.

In the Figure 4 is presented a graphical scheme of EduSof system organization. The system is organized in three separate modules, each of which is realized in such a way that enables its easy use even by the user with no much experience in using computers; the modules are menu-driven and user-friendly.

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Teacher, Beta version

Figure 5 Module Teacher
The creating module Teacher (Figure 5), serves for designing lessons by the teacher of the subject, module Learn (Figure 6) is a kind of the interpreter of the knowledge introduced by the Teacher module, which is used by pupils in the course of mastering the subject - matter and acquiring the pertinent knowledge. The third module can be used for different testing of pupils for the purpose of marking.

5. CONCLUSION

EduSof has great abilities of representing knowledge through teaching sequences in all fields of educational process. Text information is enlarged with graphics and simulation information. So, EduSof is a tool, some kind of knowledge interpreter, easy to use, with a minimal need for experience in using the computer, assuming that making the programs for simulations would be a job of qualified people, professional programmers. In contrast to simulation procedures, the use of graphical presentation requires the knowledge of some of ready - made graphical packages (Dr Halo, Animator, and the like), as well as the use of some of tools for connecting the pictures drown in the EduSof system.

For purpose of testing of EduSof system, with the help of qualified teachers, several lessons from physics, chemistry, programming, biology, and mathematics, have been prepared. These teaching sequences were used for training and knowledge acquiring by pupils in special summer courses during 1991 in Loznica (Yugoslavia). The test results of the pupils that used EduSof system were superior to those shown by the pupils which were taught the same sequences by classical method.

Further research will be in the direction of incorporating into EduSof the possibility of response recognition of spoken language, and resolving other AI problems, such as drawing conclusions, possibility of computer generating of new lessons, etc., with the aim to make EduSof applicable in as much as possible of cases and subjects.
REFERENCES


