

DEVELOPMENT OF A PROBLEMSOLVING SUPPORT FOR AN INTELLIGENT TUTORING SYSTEM

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Abstract—Recent changes in technology make it possible to distribute Intelligent Tutoring System so that students can benefit from adaptive software. Many social benefits can flow from wider access to ITSs. An extensible architecture is described for deploying Intelligent Tutoring System in student- centered manner. Authoring tools now exists which trade the depth of intelligence to make ITSs accessible to less technically skilled students. ITS attempts to bring in aspect human-teacher delivering personalized tutoring to a student. This paper highlights on developing tutoring system which will teach quadratic equation by factoring to the students effectively as human teacher does. This paper focuses on the various modules of ITS and also focuses primary duty of an ITS which is problem solving support means providing support when student faces any problem during problem solving.

Keywords— Domain knowledge base module, Intelligent Tutoring System (ITS), Pedagogical module, Problem solving support, Student module, User Interface.

1. INTRODUCTION

Emerging of a knowledge society and growing demands for highly skilled and educated labor force claim for changing traditional teaching and learning processes. One way of changing is related with an integration of various kinds of computer-based learning systems as supplement to conventional teaching methods. However, it is necessary to provide intelligent and adaptive abilities of a software system in order it could take over a role of a teacher in effective way. Solving of domain problems is an important part of Intelligent Tutoring System (ITS), as it allows deepening the acquired theoretical knowledge

in practice, but the mere solving is unlikely to lead to improved skills or deeper understanding of a subject matter. Learning often takes place best when the learner receives feedback from the system. Feedback is a way to improve the learning process based on continuous assessment of learning results, the analysis of their quality and performance of necessary corrections. Feedback encourages desired learning behavior and discourages undesired one, allows understanding how successfully the learner acts, whether he/she applies relevant knowledge, and it provides opportunities to correct misconceptions [1].

2. INTELLIGENT TUTORING SYSTEM

2.1 *Background Approach*

The use of artificial intelligence techniques to educational software design influenced the evaluation from computer assistance instruction (CAI) to Intelligence Tutoring Systems (ITS). It has been tried to incorporate ‘Intelligence’ in the areas of knowledge, problem solving, tutoring and communication with the student in order to create a system which is expert in a particular field also be able to provide individualized instruction. ITS attempts to simulate such a ‘Teacher’ who guides the student lesson’s flow, use pedagogical methods suitable to a student and monitor progress on an individual’s basis on his/her understanding in the subject.

ITS for mathematical problems was planned and designed to meet up the following objective.

- I. To facilitate student in learning integration.
- II. To diagnose on student errors and effectively generate explanation for those errors
- III. To offer a student monitoring system that includes learning progress and relevant statistical data.

2.2 *Why is tutoring effective?*

Although a precise answer to this question of why tutoring is more effective than other forms of instruction has remained elusive, most explanations focus on the fact that the best tutor balance the need the need for active participation of the student with the provision of guidance. This means the student does as much of the work as possible while the tutor provides just enough feedback minimize errors done by the student. Also,

effective tutoring has more to do with the interaction between the tutor and student [3].

2.3 Authoring Tools

Authoring tools have been created which enable instructor to create ITS through an interface built on generalized concepts of teaching strategy and domain knowledge. Preliminary training is needed, but the level of expertise needed to construct a tutorial is vastly reduced [4]. The blend of Intelligent Tutoring System and Adaptive hypermedia has evolved into adaptive web-based education systems. It is now possible to redefine the discrete intelligent tutor. The component of a tutor can belong more than one system. If a particular component is networked-based, then other system can share it.

The goal of authoring tool is to provide a (relatively) simple development environment and as a result fewer developers would be needed for the construction of educational software.

There are two main approaches to achieve this goal.

- I. Provides a simple development shell for educators to author their own courseware.
- II. Provides a mean for programmers to more easily represent the domain and teaching strategies.

Authoring tools that fall into first category generally have a restricted scope of the types of instructional interaction a user can create, whereas those in second category allows for considerably more flexibility at the cost more complex authoring.

3. TYPES OF ITS

There are mainly two types of Intelligent Tutoring System are identified according to system's objective [3]. The two types are defined as follows,

- I. Problem Solving.
- II. Curriculum Sequencing.

3.1 Problem Solving Support-Problem solving support was considered as the primary duty of an ITS [5]. The purpose of the problem-solving support is usually to provide the student with intelligent help for each step when resolving tasks such as problem. When the student is stuck on one step the system provides hints showing the next correct solution step for the student or offering appropriate error feedback. In this situation the critical problem for the system is interpret the students' actions and infer the solution

plan that the student is currently following based on a partial sequence of observable action. That is the system needs to understand the student plan and applying this understanding to provide help.

3.2 **Curriculum Sequencing**-Curriculum sequencing is now the most popular and important technology in web based ITSs [7]. The objective of curriculum sequencing technology. [7] is to provide the student with a personalized optimal path through the learning material. The examples are recommending appropriate learning sequencing is necessary in web-based education. Web based learning student usually work alone without a teacher's instructional assistance, and they study the subject at their own pace. As a result, appropriate learning sequencing recommendations are essential in order to enable each student to learn the subject in the most beneficial and individualized way [7].

4. THE PROBLEM-SOLVING MODES

Generally, there are two possibilities regarding moments of feedback delivering: immediate feedback after each step or action in problem solving and feedback after submission of a whole solution to the problem. It is basis for two modes of problem solving in the proposed approach. In the completeness mode the learner chose the moments of

Feedback presentation to check correctness of a series of steps. So, he/she can perform series of steps solving a problem and then to require checking of the performed steps. The system provides feedback about correctness of his/her previous actions and the learner by his/herself should determine what steps had led to the incorrect solution. This mode is similar to reinforcement learning [9] which is widely used in artificial intelligence. In the step-by-step mode the system monitors each problem -solving step and gives feedback about its correctness.

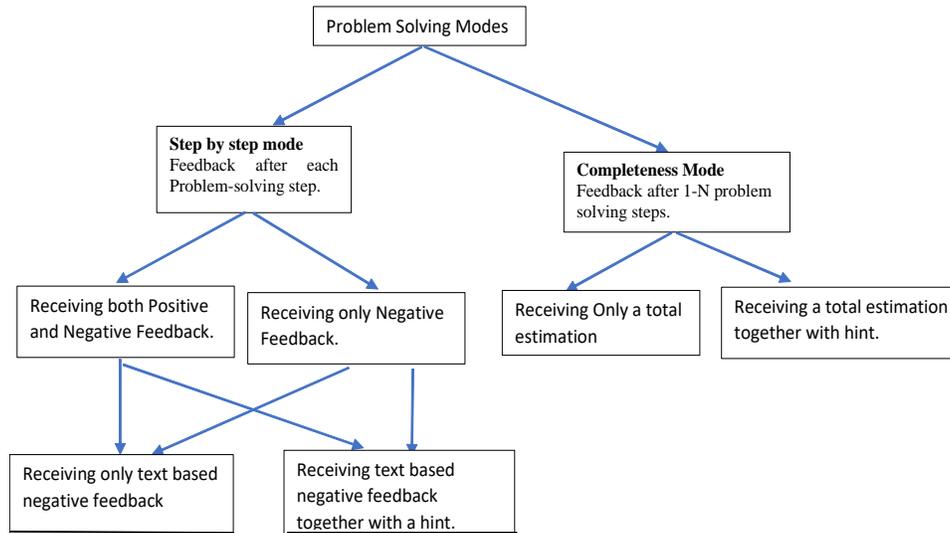


Fig.1: Problem-solving modes and kinds of feedback.

5. ARCHITECTURE OF PROBLEM-SOLVING SUPPORT FOR AN ITS

In this section the architecture of problem-solving support for an ITS is defined. Here we have taken common framework [10] of the ITS. The components of the defined architecture are described in following subsequent manner. Here quadratic equation has been taken for the domain of the defined Intelligent Tutoring System. The outline of the system describes the major components and how they are interacts with each other.

5.1 The architecture of proposed ITS.

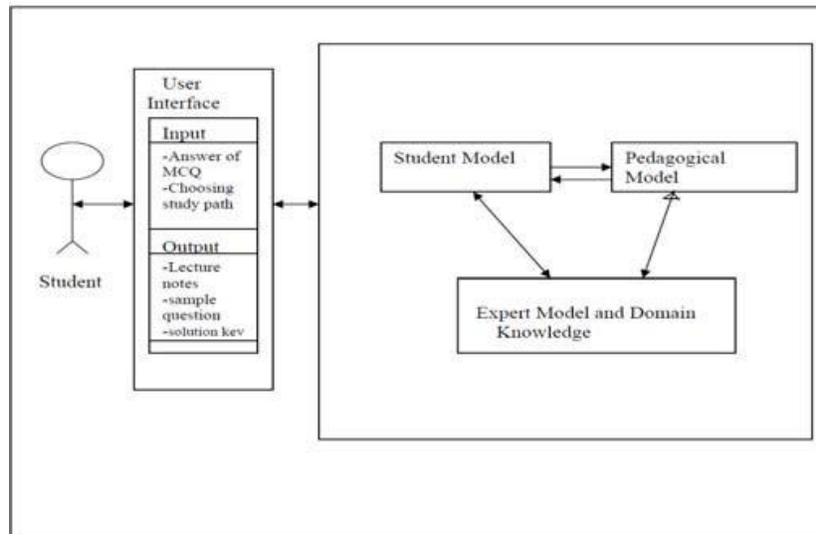


Fig.2: Architecture of problem-solving support for an ITS.

5.1.1 *Domain Knowledge:* Domain knowledge contains the lecture notes in the form tutorial pages. The class lecture notes are displayed while the student learns a new concept all course material including both lecture notes and questions are organized by knowledge concepts for quadratic equation. Here lecturer notes are separated from the actual instructional contents so that individual can set the tutorial in his/her own way as shown in Fig3.

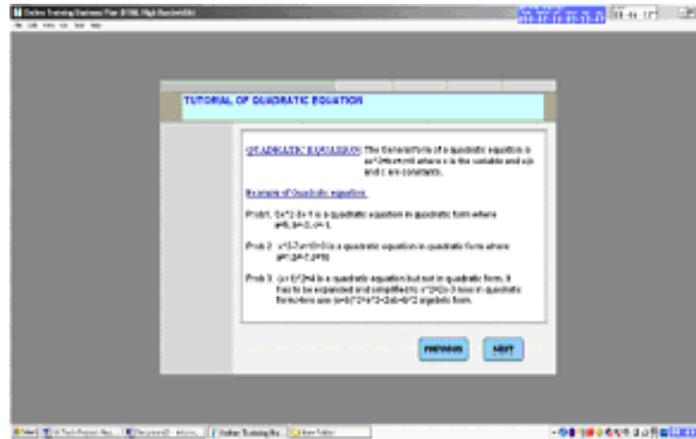


Fig.3: Showing the domain knowledge of the system.

5.1.2 *Student Model:* It stores the information about individual learner. At a minimum it tracks how well a student is performing on a material being taught. Means he/she understood the topic or not, whether he/she can answer the problem given in exercise or not. The output of model becomes the input of the pedagogical model which tailors the learning process to the needs of the learner as shown in Fig4.



Fig.4: Showing the student model.

5.1.3 *Pedagogical Model:* The pedagogical model provides teaching process. Like

when to review, when to move to a new topic, when to provide problem solving support to find out correct solution. The student model is used as input to this model. So the pedagogical model defines the needs of the learner to solve the problem as shown in Fig 5. Following are some cases which pedagogical model deals with during the learner learn the tutorial.

Case 1:

Input: After visiting the tutorial pages the student asked to do some problems.

Output: The student are supplied a set problems.

Case2:

Input: The student isn't ready to solve the problems.

Output: Suggest the re-reading the tutorial.

Case 3:

Input: The student can answer the supplied question at first entry.

Output: He will be supplied next the question.

Case 4:

Input: The student can't answer at the first try.

Output: Supply option of further try or support.

Case 5:

Input: Student take support.

Output: Provide support.

Case 6:

Input: Student can't answer up to feasible level.

Output: Suggest reviewing.

The six steps are repeated for each problem until the student completely studies the courseware. Though, it is possible that the student can quite from the system at any time before the completion of the course.

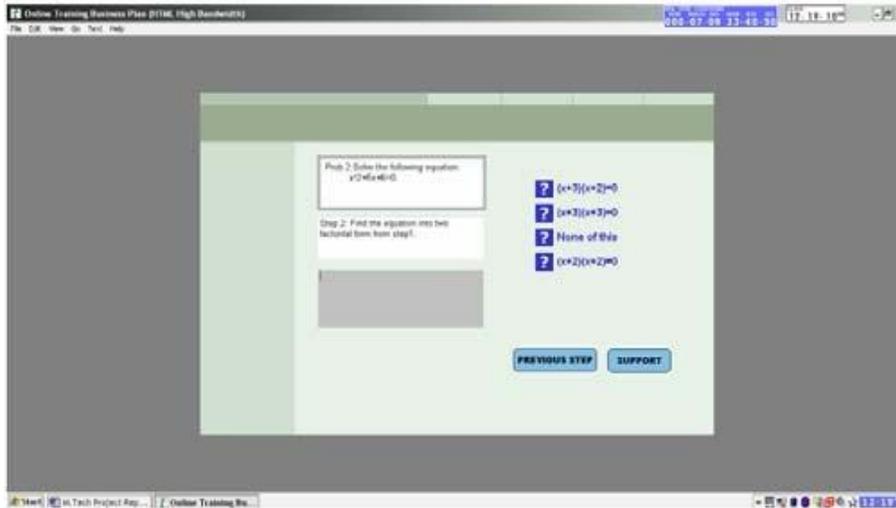


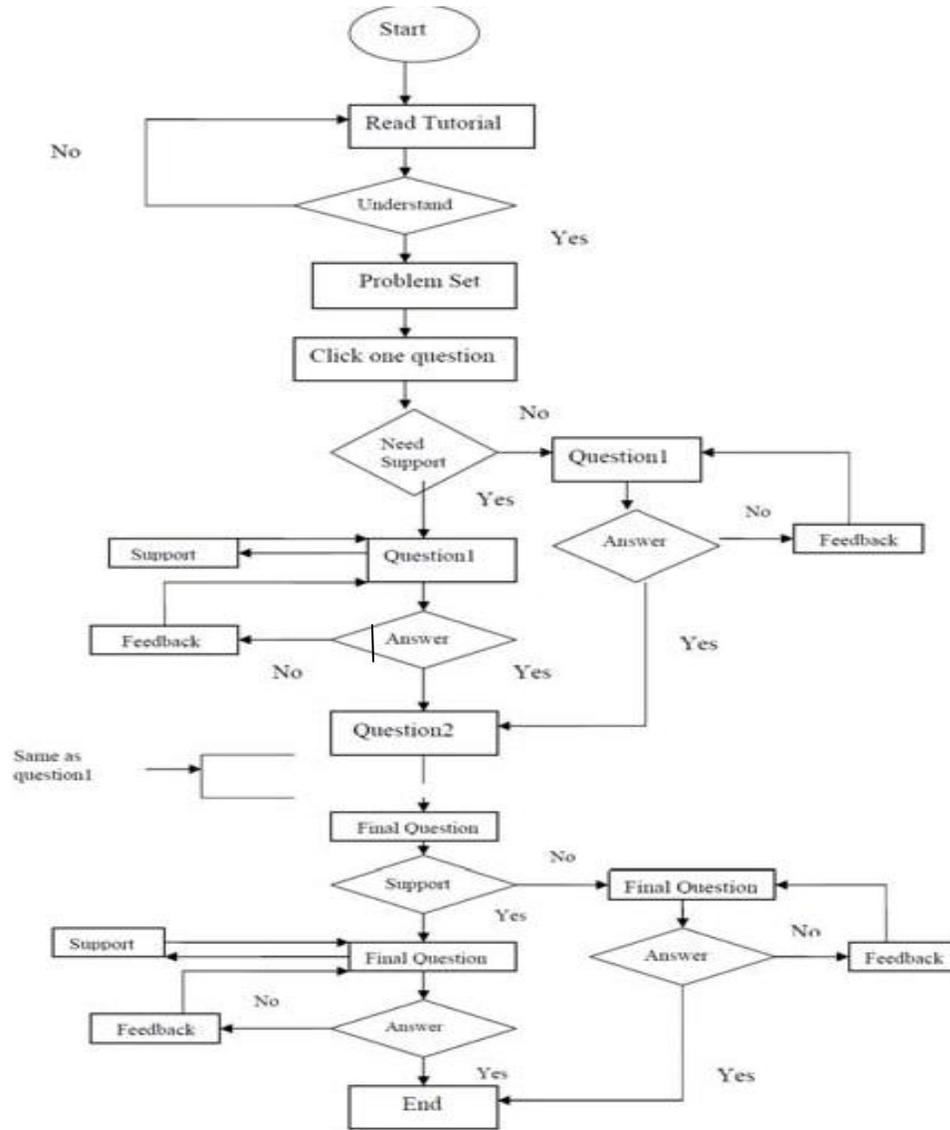
Fig.5: Showing the pedagogical model.

5.1.1 *User Interface Model:* A student interacts with ITS through the user interface model as shown in Fig 6. This interaction is partitioned into two sub modules: an Input module that takes input from the student to ITS ,and an Output module for output from ITS to student. The Input module displays the interface where the user or student can put their input. The output module displays the lecture notes, feedback depending on the answer. It means that if the student does some mistakes, then the system can suggest reviewing the lecture notes or showing some advice.



Fig.6: Showing the user interface.

Flow chart of teaching process for quadratic equation



6. ISSUES IN PROBLEM DESIGN

The issues which are to be considered for designing the problem-solving support of an Intelligent Tutoring System are as follows,

For Mentor

First step: How to design the course?

Tutor must first design her own course structure. Basically, the whole course is divided into two parts, a lecture notes and a set of problem. In lecture notes the tutor can add any

no of notes.

Second Step: Adjust the problem set.

Here the tutor set questions, options, and correct answer (which will be compared with the learner's answer).

Third step: Accommodate help topic.

Tutor set the help topic for the learner if the learner asks for this. Also, a support is given to the learner (In my project a support is given along with the problem).

For Student

A student can do the following things.

1. Read the material.
2. Give an objective question set.
3. Take help or support if needed.

7. PURPOSE OF AN INTELLIGENTAGENT

1. The agent will suggest the student that he/she should read topic time by time.
2. The agent will tell the student when read topic, given feedback to the student if he/she did some mistakes, provide support if the student is needed.
3. The agent will try to help the student to complete the course as efficient learning path as possible.

8. ADVANTAGES OF THE PROPOSEDITS

1. Easy to access tutorial for the learner.
2. Functionalities for easy monitoring of student's work.
3. Provide support whenever student needs support.
4. Provide feedback to the student whenever he/she do some mistakes.

9. DISADVANTAGES OF THE PROPOSEDITS

1. Whenever student study lesson can only start from very first and then follow the next

- sections. Can't start from any section of his/her choice.
2. All the support are provided in single step. Step-by-step support is not provided here.

10. . CONCLUSIONS

Intelligent tutoring systems have made significant strides in last few decades in well-defined domains. The paper has suggested an increase in focus on the problems posed by tutoring in mathematical domain. The specific advantage of that project is its ability to represent domain knowledge and scaffold learning in interactive and deep ways that are not possible in other kinds of learning environments. For situations when human guidance is unavailable or of limited availability, ITS techniques can help fill this void by giving automated feedback to learners. In this project basically two types of users are involved in this ITS. They are as follows,

1. Virtual tutor: - Its role is to be as lesson administrator to track progress of student learning and help him/her with their tasks.
2. Student: The student will take the Quadratic equation tutorial and use that system in order to gain certain level of knowledge.

REFFERENCES

1. Anderson, J.R. and Bower, G.H.(1973). Human associative memory. Washington, DC: V.H Winston and Sons.
2. Anderson, J.R. (1983). The architecture of cognition.Cambridge, MA: Harvard University
3. Alven V., McLaren, B., Sewall, J., Koedinger, K.R. (2006). The Cognitive Tutor Authoring tools (CTAT): Preliminary evaluation of efficiency gains. In M.Ikeda, K.Ashley, &T.W.Chan (Eds), Intelligent Tutoring System 2006, LNCS 4053 (pp.61-70). Berlin: Springer-Verlag.
4. T. Murray, Authoring intelligent tutoring systems: An analysis of the state of the art, International Journal of Artificial Intelligence in Education, 10 (1999) 98-129.
- 5.P.Brusilovsky, Adaptive and intelligent technologies for web-based education, Special Issue on Intelligent Systems andTeleteaching,4(1999)19-25,1998,pp,106-111.
6. Mayaank Jain, A generalized knowledge representation Architecture for Intelligent Tutoring System, (May, 2008).
7. M. Urban-Lurain, Intelligent tutoring systems: An historic review in the context of the development of artificial intelligence and educational psychology.
8. J.S.Brown and R.R.Burton A paradigmatic example of an Artificially Intelligent Instructional System,

International Journal of Man-Machine studie. Vol.10,pp.323-339, 1978.

9. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 2003.
10. C.J.Butz, S.hua, R.B. Maguire: A web based Bayesian Intelligent Toting Systems for Computer Programming.
11. Bransford J.D., Brown, A.L., & Cocking, R.R.(Eds.). (2000) How people learn: Brain, Mind, Experience and School. Washington,DC: National Academic Press.
12. Bangert-Drowns, R.L., Kulik, C.C., Kulik, J.A and Morgan, M. (1991). The instructional effect of feedback in test-like events. Review of Educational Re search, 61,213- 238.
13. Chi, M.T.H.,Siler,S.A.,Jeong,H.,Yamaguchi.,& Hausmann, R.G. (2001). Learning from human tutoring. Cognitive Science 25,471-533.
14. Merrill, D.C., Reiser, B.J. Ranney, M., & TraftonJ.G. (1992). Effective tutoring techniques: A comparison of human tutors and Intelligent tutoring systems, The Journal of the Learning Sciences, 2(3),277-305.
15. Bielaczyc, K., Pirolli, P.L. and Brown, A.L. (1995). Training in self-explanation and self- regulation strategies: Investigating the effects of knowledge acquisition activities on problem solving. In Cognition and Instruction, 13, 221-252.