

# CSA402

## Lecture 16

### Closed-world AHSs using ITSs as an example

#### Reference

Wenger, E. (1987). Artificial Intelligence and Tutoring Systems: Computational and Cognitive Approaches to the Communication of Knowledge. Los Altos, CA: Morgan Kaufmann Publishers, Inc.

## Overview

- Modern ITS development began in 1987, after a review by Wenger
- This was the first attempt to examine the implicit and explicit goals of ITS designers
- He described ITS as a part of "knowledge communication" and his review focused on cognitive and learning aspects as well as the AI issues

"... consider again the example of books: they have certainly outperformed people in the precision and permanence of their memory, and the reliability of their patience. For this reason, they have been invaluable to humankind. Now imagine active books that can interact with the reader to communicate knowledge at the appropriate level, selectively highlighting the interconnectedness and ramifications of items, recalling relevant information, probing understanding, explaining difficult areas in more depth, skipping over seemingly known material ... intelligent knowledge communication systems are indeed an attractive dream." (p. 6).

- Motivations underlying ITSs (and education in general):

to teach *about* something (abstract)  
to teach *how to do* something  
(practical)

- How can learning be achieved?

By rote

By mimicry (observation)

By application

- When student performs task correctly,  
assume student understands concept  
and/or its application
- When student performs task  
incorrectly, how can the tutor help?

Simply tell the student the correct  
answer

Tell student the correct answer and  
state why it's correct

Explain to the student why his/her  
answer is incorrect

- Explanation-based correction is  
**HARD!**

- Tutor must first understand why the student gave the incorrect answer

Incorrect application of correct procedure

Misinterpretation of task

Misconception of principle

- How to tutor?

Originally Computer-Aided Instruction (CAI) systems used non-interactive "classroom" techniques.

All students were shown taught in the same manner (e.g., through flash cards) and then they were assessed.

If a student failed, then it was up to the student to work through the same material again, to "learn it better"

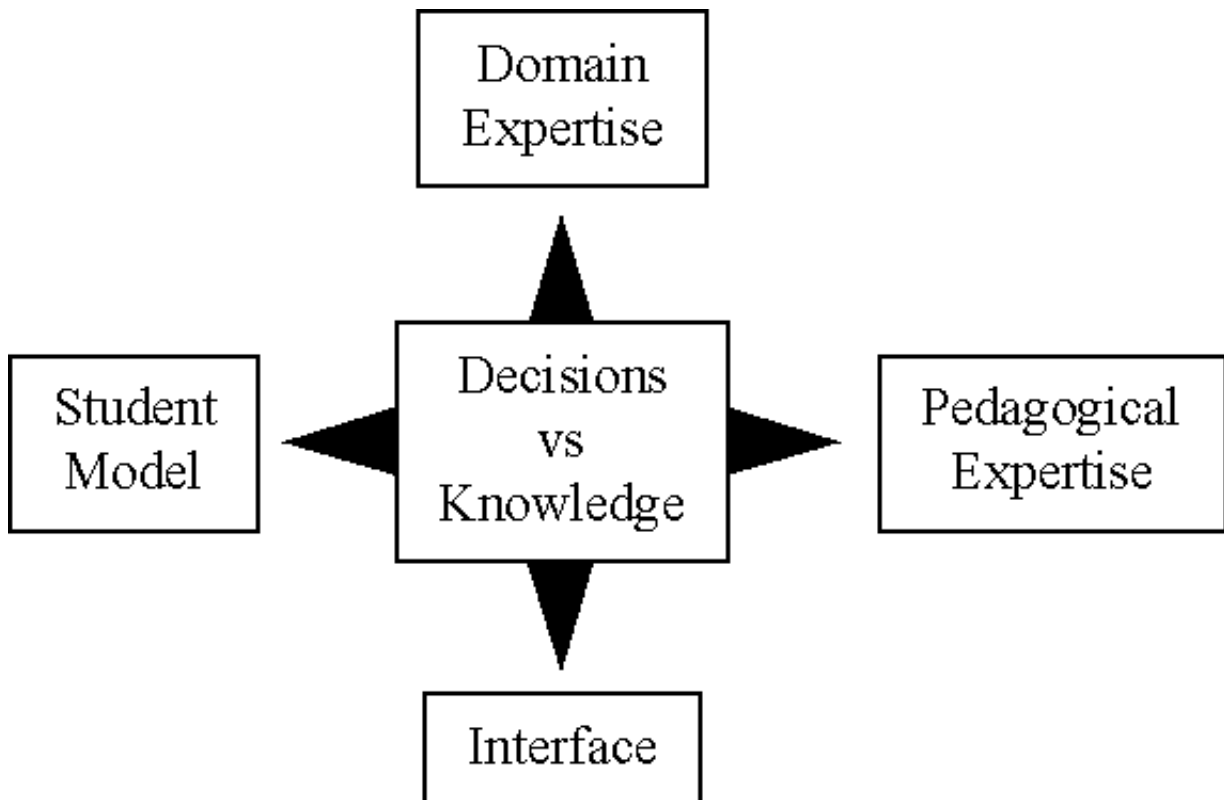
Students had access to a human supervisor to address difficulties

This type of learning, although self-paced, is ineffective

## The goal of an ITS

- A student learns from an ITS by solving problems.
- The ITS system selects a problem and compares its solution with that of the student
- It performs a diagnosis based on the differences.
- After giving feedback, the system reassesses and updates the student skills model and the entire cycle is repeated.
- As the system is assessing what the student knows, it is also considering what the student needs to know, which part of the curriculum is to be taught next, and how to present the material.
- It then selects the next problem/s.

## Basic issues in knowledge communication



## Domain Expertise

- Rather than being represented by chunks of information, the domain should be represented using a model and a set of rules which allows the system to "reason"
- Domain model architectures are typically represented as

If - Then Rules

If - Then Rules with uncertainty measures

Semantic Networks

Frame based representations

## Student Model

- According to Wenger, student models have three tasks

They must gather information about the student (implicitly or explicitly)

They must create a representation of the student's knowledge and learning process (often as "buggy" models - models that highlight deviations from expert knowledge)

They must perform a diagnosis to determine what the student knows and to determine how the student should be taught and to identify misconceptions

- Student model architectures

Overlay student models

Differential student models

Perturbation student models



- Student model diagnosis

Performance measuring

Model tracing

Issue tracing

Expert systems

Pedagogical expertise

- Used to decide how to:

present/sequence information

answer questions/give explanations

provide help/guidance/remediation

- According to Wenger, when "learning is viewed as successive transitions between knowledge states, the purpose of teaching is accordingly to facilitate the student's traversal of the space of knowledge states." (p. 365)

- The ITS must model the student's current knowledge and support the transition to a new knowledge state.
- ITSs must alternate between diagnostic and didactic support.
- Diagnostic support

Information about a student's state is inferred on 3 levels

*Behavioural* - ignores learner's knowledge, and concentrates on observed behaviour

*Epistemic* - attempts to infer learner's knowledge state based on learner's behaviour

*Individual* - cognitive model of learner's state, attitudes (to self, world, ITS), motivation

- Didactic support

Concerned with the "delivery" aspect of teaching

## Interface

- The interface is the layer through which the learner and ITS communicate
- The design of an interface which enhances learning is essential
- Web-based ITSs tend to rely on the Web browser to provide the interface
- Hypermedia-based ITSs in general must provide adaptive presentation and adaptive navigation facilities, if they are to extend beyond knowledge exploration environments

