ALT Pathway: Synthetic Tutors for High School Physics

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Motivation

• Effectiveness of human tutoring is well established (The 2-sigma problem)1,2

• Human tutoring is not, however, cost effective to implement

• Computer-based tutors represent a potential solution3

(1) Bloom, 1984
(2) Cohen, 1982
(3) Ref, 1999

Conceptions of Tutoring

What makes tutoring so effective?

• The Tutor?

Conceptions of Tutoring

What makes tutoring so effective?

• The Tutor?

• The Student?
Conceptions of Tutoring

What makes tutoring so effective?
• The Tutor? ✗
• The Student? ✓

In tutoring environment students:4-5:
1. construct explanations
2. ask “deep” questions
3. evaluate understanding

(4) Chi, 1996
(5) Chi, 2004

Conceptions of Learning

Piagetian Constructivism6
• Students are not blank slates; they have prior knowledge
• Students must construct their knowledge

Learning Environment and Curriculum must be Considered Together

(6) Inhelder and Piaget, 1958

Conceptions of Learning

Learning Cycle7,8
• A teaching construct which facilitates student learning

1. Exploration
2. Formal Intro.
3. Application

(7) Karplus, 1977
(8) Zollman, 1990

System Design

What do we teach?
Newtonian Mechanics: A Foundation of Physics

Look to the Force Concept Inventory9:
Three cases:

(9) Hestenes, 1992

System Design

What do we teach?
Newtonian Mechanics: A Foundation of Physics

F is zero
F is Impulsive
F is constant

(9) Hestenes, 1992
System Design

How do we create a virtual tutor?

Previous Work & Enabling Technology

• Synthetic Interview Technology

• Informedia Digital Video Library

Physics Pathway Website

• Teaches In-Service and Pre-Service Physics Teachers
• Utilizes Synthetic Interview to answer questions
• Utilizes Informedia Digital Video Library to demonstrate physics

Previous Work & Enabling Technology

Physics Pathway Website

Previous Work & Enabling Technology

Research Opportunities

How do we simulate tutoring?

Step 1: Study Real Tutoring
1. Face-to-face tutoring
2. “Wizard of Oz” Experiment
Research Opportunities

How do we simulate tutoring?

**Step 2: Generate an Intuitive, Useful Interface**

Technologies for Creating Interface:
- Layered Video
- Physics Applets
- Tablet PC’s
- Table top demos using household items

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Research Opportunities

How do we simulate tutoring?

**Step 2: Generate an Intuitive, Useful Interface**

Key Problem:

How do we simulate the interactivity without excessive “branching”?

**Question**

A1  A2  A3
Q1  Q2  Q3

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Research Opportunities

How do we simulate tutoring?

**Step 3: Test and Refine the Interface**

- Examine effect of varying the interaction of SI and iDVL materials

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Research Opportunities

How do we know if it works?…That is the Question

**Methods for Judging Learning:**
- Interviews to probe deep understanding
Research Opportunities

How do we know if it works?…That is the Question

Methods for Judging Learning:
• Interviews to probe deep understanding
• Task as Measure of Understanding

Conclusions

We’re just getting started, but we’re developing an increasingly solid plan for generating our tutoring system and testing it.

References