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 solution[3]

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

Motivation

- Effectiveness of human tutoring is well established (The 2-sigma problem)[1,2]
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GOAL: Develop and test such a web-based tutor

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

Conceptions of Tutoring

What makes tutoring so effective?

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 Constructivism[6]

- Students are not blank slates; they have prior knowledge
- Students must construct their knowledge

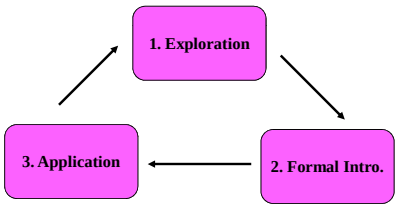
Learning Environment and Curriculum must be Considered Together

(6) Inhelder and Piaget, 1958

Conceptions of Learning

Learning Cycle[7,8]

- A teaching construct which facilitates student learning



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

System Design

What do we teach?

System Design

What do we teach?

Newtonian Mechanics:A Foundation of Physics

(9) Hestenes, 1992

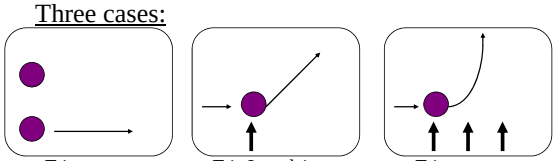
System Design

What do we teach?

Newtonian Mechanics:A Foundation of Physics

Look to the Force Concept Inventory[9]:

Three cases:



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

Previous Work & Enabling Technology

Physics Pathway Website[10]

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

Physics Pathway (teaching advisory)

(10) http://www.physicspathway.org

Previous Work & Enabling Technology

Physics Pathway Website[10]

Unconnected iDVL allows user to look up related video clips

Synthetic Interview Personae Explains answers

(10) http://www.physicspathway.org

Research Opportunities

How do we simulate tutoring?

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How do we simulate tutoring?

<u>Step1: Study Real Tutoring</u>

1. Face-to-face tutoring

2. "Wizard of Oz" Experiment

Research Opportunities

How do we simulate tutoring?

Step 2: Generate an Intuitive, Useful Interface

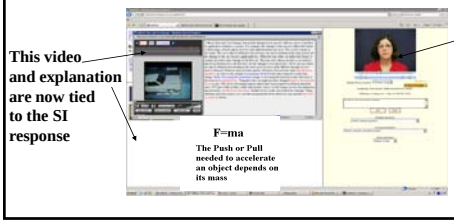
Technologies for Creating Interface:

- Layered Video
- Physics Applets
- Tablet PC's
- Table top demos using household items

Research Opportunities

How do we simulate tutoring?

Step 2: Generate an Intuitive, Useful Interface



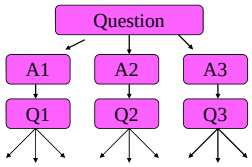
Research Opportunities

How do we simulate tutoring?

Step 2: Generate an Intuitive, Useful Interface

Key Problem:

How do we simulate the interactivity without excessive "branching"?



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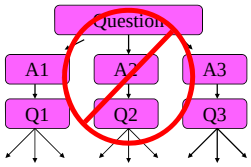


Research Opportunities

How do we simulate tutoring?

Step 3:Test and Refine the Interface

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

Research Opportunities

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

Methods for Judging Learning:

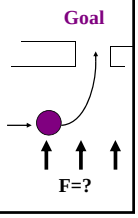
- Interviews to probe deep understanding

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.

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