Supple Interfaces for Education

Can Affective Interactions Improve Learning via Educational Games?

Cristina Conati

University of British Columbia

Educational Games

- Educational systems designed to teach via game-like activities
- Pros: generate high level of emotional engagement and motivation.
- Cons:
  - Often possible to play the game without understanding the underlying knowledge
  - Suitable only for certain types of learners

Our Solution

Socially Intelligent Pedagogical Agents that

- Monitor how students learn from a game
- Generate tailored interventions to trigger constructive reasoning…
- …while maintaining a high level of emotional engagement

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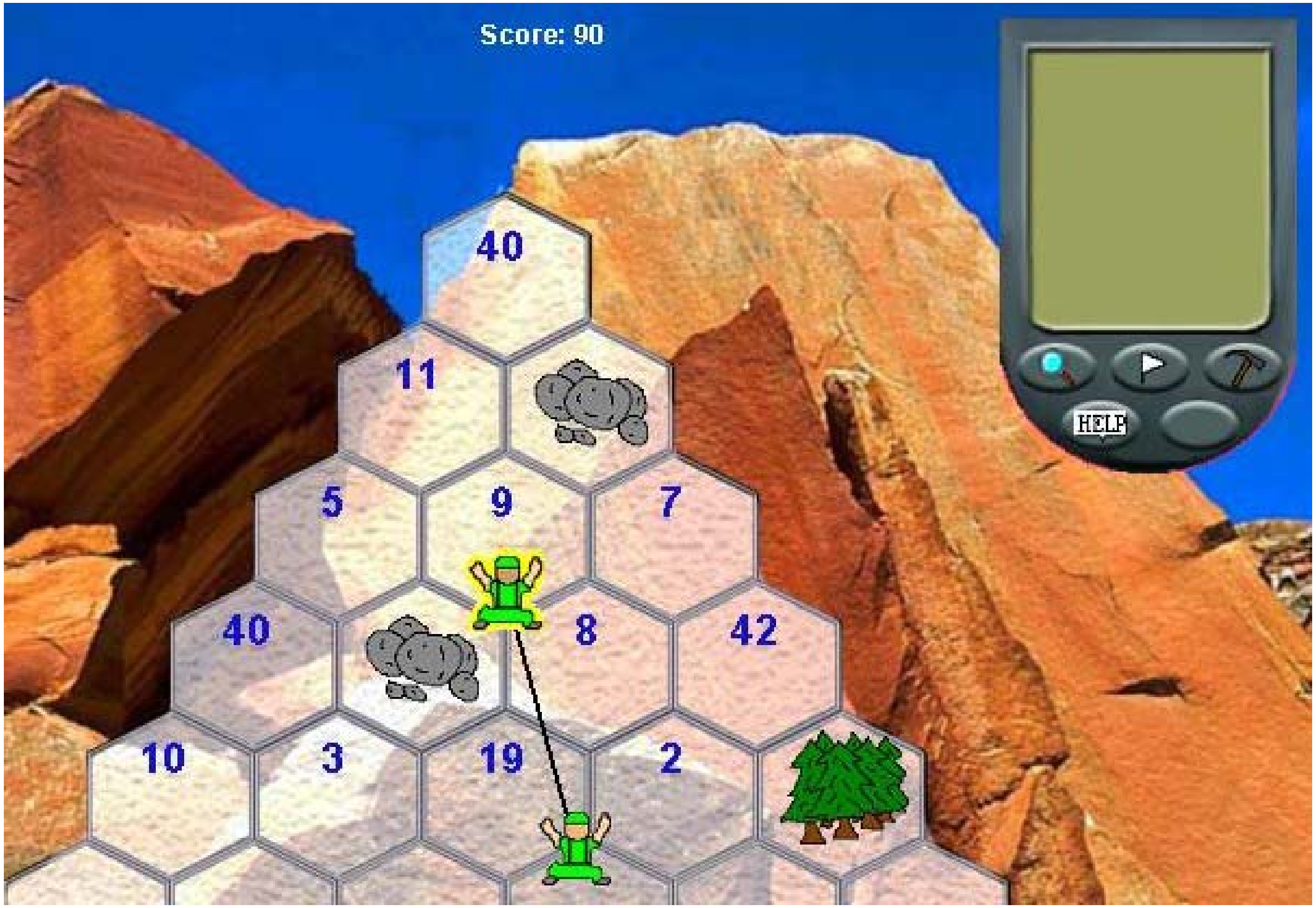
Crucial to model affect in addition to learning

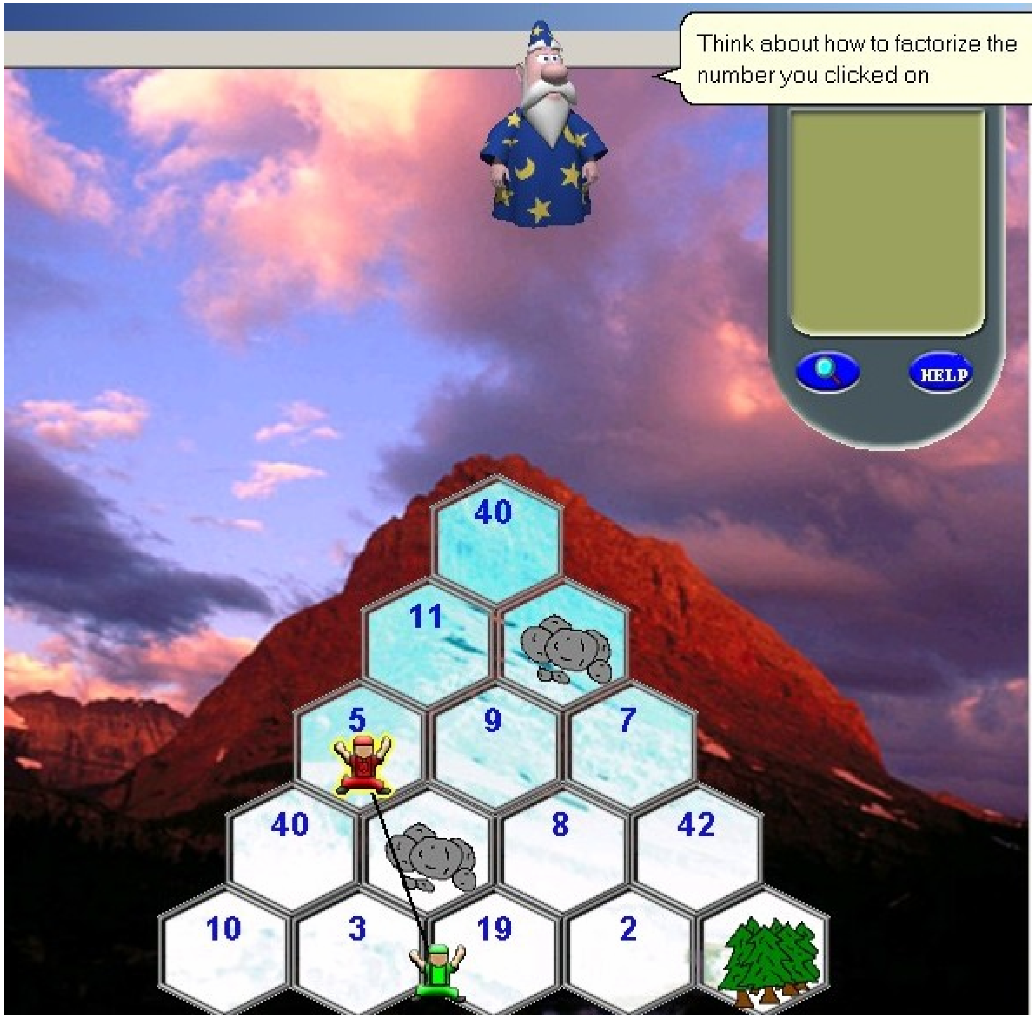
The Prime Climb Educational Game

Developed by EGEMS group (Electronic Games for Education in Math and Science) at UBC



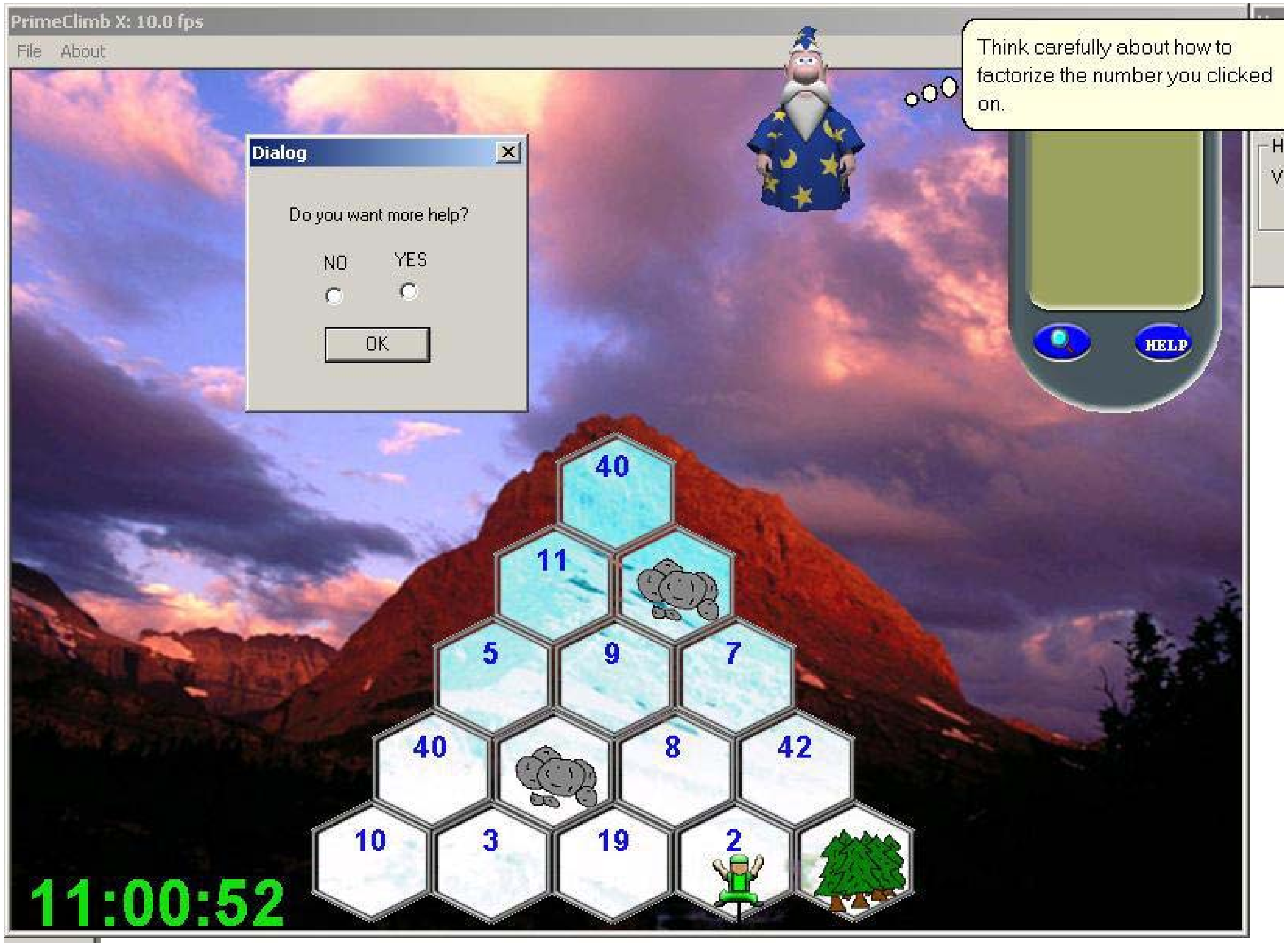
The Prime Climb Pedagogical Agent

- Answers to students' help requests
- Provides unsolicited hints to help students learn from the game
- Hints at incremental level of detail, based on
  - A model of student learning (Manske and Conati 2005) - for now
  - AND a model of student affect (Conati and Mclaren, 2004, 2005) – in the future



Hints at Incremental Level of Detail (1)

- Focus student attention on the relevant concept (number factorization or common factors)



Hints at Incremental Level of Detail (2)

- Teaching hint: definitions + examples

- Bottom-out hint: give the student explicit answer

“ you fell because 42 and 2 share 2 as a common factor”

- Hints designed by an experienced ex-teacher, revised by teachers and pilot tested

Probabilistic Student Model of Student Learning

(Manske and Conati 2005)

- Generates probabilistic assessment of whether the student:
  - Knows the factorization of specific numbers
  - Understands the concept of common factors
- Iterative process of design and evaluation: two versions of the model:
  - First one not very accurate
  - The second (statistically) significantly better

User Study

- **Goal:** investigate the effect of an increasingly accurate model on the effectiveness of the agent's adaptive behavior
- **Hypothesis:** the better the model, the better the Pedagogical Agent
- **Design**
  - 41 students, 6^{th} and 7^{th} grade, 3 conditions
    - » no agent (control, 13 students)
    - » innaccurate student model (14 students)
    - » accurate student model (17 students)
  - Log data, pre and post-test, questionnaire on agent's acceptance

Results

- No differences in student learning, very little learning:
- Students prefer the agent with the less accurate model

Is (does) the agent	**Old Model**	**New Model**	
Helpful	3.6	2.56	$p<0.05$
Understands when I need help	3.0	2.67	
Makes me learn factorization	3.2	2.56	
Intervenes too often	3.2	3.89	

- Despite the fact that

Results

- The new model is better at
  - detecting student lack of knowledge: 77.5% vs. 3.3% true negative rate, or specificity
  - generating precise interventions, i.e. being correct when it says that something is unknown: 58% vs. 17%
- That is, the new model makes the agent intervene more often, but rightly so

Discussion

- Likely problem with the agent + accurate model:
  - it does not take into account student affect: ***it becomes too didactic***
- But how should the agent use affective information to foster learning?
  - Always keep student in positive affective state?
  - Are there some states of negative affect that can be good for learning?
  - What is a good tradeoff between affect and learning?

Current/Future Work

A Decision Theoretic Agent for Prime Climb

Model of Student Learning
(Manske and Conati, 2005)

Model of Student Emotional State
(Conati an Mclaren 2004, 2005)

?

Possible actions
+
predicted effect on learning and affect

?

Select action that optimizes balance between learning and engagement