“Excuse me, I need better Artificial Intelligence!”

Igniting Students' Intrinsic STEM Motivation through Game Design.

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Motivation

intrinsic versus extrinsic
kids today...

- have no attention span
- are selfish
- are materialistic
- are lazy
- just want to play video games and use Facebook
Chocolate Covered Broccoli

“A broccoli recipe you won't soon forget, this chocolate-covered broccoli is a clever way to get picky eaters to eat vegetables”
anatomy of a bad idea

1) valuable stuff but not likely to be enjoyed based on intrinsic motivation

2) tasty cover up serving as extrinsic motivation

3) arbitrary integration to solve problem

1) valuable stuff but not likely to be enjoyed based on intrinsic motivation
Math Education
for the intrinsic motivation challenged

Math Blaster, Trash Zapper
more shooting...
anatomy of a bad idea

1) valuable stuff but not likely to be enjoyed based on intrinsic motivation

2) tasty cover up serving as extrinsic motivation

3) arbitrary integration to solve problem

STEM is intrinsically boring

1) valuable stuff but not likely to be enjoyed based on intrinsic motivation

shooting

educational game
part 2
Computational Thinking
instead of shooting
21st Century Skills

- "Computational Thinking" is a national priority (National Science Foundation, National Academy of Science)
- Jobs: Bioinformatics, Cheminformatics, Chemometrics, Computational biology, Computational chemistry, Computational economics, Computational electromagnetics, Computational engineering, Computational finance, Computational fluid dynamics, Computational forensics, Computational geophysics, Computational linguistics, Computational mathematics, Computational mechanics, Computational neuroscience, Computational particle physics, Computational physics, Computational statistics, Computer algebra, Environmental simulation, Financial modeling, Geographic information system (GIS), High performance computing, Machine learning, Network analysis, Neuroinformatics, Numerical weather prediction, Pattern recognition, ...
Computational Thinking definition

Good news: we have come a long way

◆ 2009
  ◦ CT ≠ Programming
  ◦ example: “grandma baking a cake”

◆ 2011: CSTA, ISTE, NSF: Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following characteristics:
  ◦ Formulating problems in a way that enables us to use a computer and other tools to help solve them.
  ◦ Logically organizing and analyzing data
  ◦ Representing data through abstractions such as models and simulations
  ◦ Automating solutions through algorithmic thinking
  ◦ Identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources
  ◦ Generalizing and transferring this problem solving process to a wide variety of problems
computational thinking tools
synthesize human abilities with computer affordances

start with question: how does a mudslide work?

express ideas computationally

visualize consequence of thinking

human abilities

computer affordances

run model

revise model
Next Generation Science Standards

- similar to Common Core
- more computational thinking

“Simple computational simulations are created and used based on mathematical models of basic assumptions.”
"Programming is hard and boring"
the pedagogy of programming

“programming, oh no... I know what is going to happen. The teacher writes a program onto the blackboard, we type it into the computer and it never works” – student
SCALABLE GAME DESIGN

strategy

exposure, motivation, education, and pedagogy
strategy Exposure

Try the vegetables once!

sneak a one week game design unit in between keyboarding and PowerPointing of “forced electives”
results Exposure

- study: over 10,000 students in inner city, remote rural, and Native American Communities
- some middle schools expose 350 students per year
- 45% girls, 55% boys
- 48% underrepresented
- Alaska, California, Colorado, Georgia, Ohio, South Dakota, Texas and Wyoming...
strategy Motivation

Scalable Game Design:

start with simple 2D games that everybody can build in a couple of hours

gradually advance to sophisticated 3D games with advanced AI, visualization, ...
results Motivation

◆ 74% of boys, 64% of girls (100% for some schools); 69% of minority students want to continue

◆ used in elementary, middle, high schools and university level
strategy Education

Computing Computational Thinking
we have created the Computational Thinking Pattern Analysis instrument that can track student learning outcomes and indicators of transfer
Systematically investigate the interaction of pedagogical approaches and motivational levels so that teachers can broaden participation
Pedagogy is the key to broadening participation.
Design for Sustainability
Project First Pedagogy

Csikszentmihalyi meets Vygotsky
Zones of Proximal Flow
show me some STEM


"excuse me, I need better AI"

game world

\[ u_{0,t+1} = u_{0,t} + D \sum_{i=1}^{n} (u_{i,t} - u_{0,t}) \]

sophisticated visualizations

advanced math (diffusion)
transition to computational science models/STEM
start your computers

◆ access AgentCubes online:
  ◆ need to have HTML5 compliant, WebGL enabled browser, e.g., Chrome, FireFox, Safari (with WebGL enabled)
  ◆ Google Chromebooks work!

◆ http://hourofcode.com/ac
know your probabilities

◆ random
conclusions

◆ Chocolate Covered Broccoli is a **bad idea**!
◆ math and science can be intrinsically interesting to students
◆ give more control to students, step back be astonished to witness what students can do and want to do
Thank you!

- [http://scalablegamedesign.cs.colorado.edu](http://scalablegamedesign.cs.colorado.edu)
- [ralex@cs.colorado.edu](mailto:ralex@cs.colorado.edu)
- [http://hourofcode.com/ac](http://hourofcode.com/ac)
- WIRED article on programming, October issue