CS/INFO 4154: Analytics-driven Game Design

Class 39:
Games for Learning
Mon

by 10:10am: Submit to CMS

wed

12/3
Kongregate Release

by 11:59pm: Kongregate Report

Fri

11/30
Games for Learning

by 11:59pm: Final Peer Evaluations
This week

Gamification

Games with a Purpose

Games for Learning
Review: “gamification”

the use of game design elements in non-game contexts

Deterding et al. MindTrek 2011
Review: Games with a purpose
Today: FUN and LEARNING

Image source: www.giantbomb.com
Outline

- Introduction and motivation
- **Discussion**: design challenges
- Role of analytics: *DOGeometry* and *RumbleBlocks*
- Case study: *DragonBox*
Outline

- Introduction and motivation
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Battleship Numberline

Lomas et al. CHI 2013
The classics

Image source: www.museumofplay.org
Math Blaster

Image source: www.giantbomb.com
The problem
Outline

- Introduction and motivation
- **Discussion**: design challenges
- Role of analytics: DOGeometry and RumbleBlocks
- Case study: DragonBox
5-minute discussion

- Is this fun? Why or why not?
- What is missing?
- What could you do to make it better?
Oregon Trail

Joe has typhoid.

Press ENTER to size up the situation

Date: April 27, 1848
Weather: warm
Health: very poor
Food: 0 pounds
Next landmark: 213 miles
Miles traveled: 341 miles

Press SPACE BAR to continue
SimCity
Minecraft
Human Resource Machine

For each two things in the INBOX, multiply them, and OUTBOX the result. Don’t worry about negative numbers for now.

You got... LABELS! They can help you remember the purpose of each tile on the floor. Just tap any tile on the floor to edit.

- inbox
- outbox
- copyfrom
- copyto
- add
- sub
- bump +
- bump -
- jump
- jump if zero
- jump if negative
- ...

Hello, Zero!
Refraction: Teaching Fractions through Gameplay
Outline

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DOGeometry

It is now possible to also mirror around the borders of the tile.

Wallner et al. CHI 2012
State transition diagrams
State transition diagrams
RumbleBlocks!
Discussion: how to measure?
Preliminary evidence

Which is more stable?

Christel et al. CGAMES 2012
Metrics

- Width of base
- Center of gravity
- Symmetry

Harpstead et al. CHI 2013
More stable =

- larger base width
- lower center of gravity
- more symmetrical

Harpstead et al. CHI 2013
What improved?

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean (SE)</th>
<th>Right direction?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td>Width of Base</td>
<td>0.60 (.01)</td>
<td>0.64 (.01)</td>
</tr>
<tr>
<td>Symmetry Angle</td>
<td>5.98 (.34)</td>
<td>5.20 (.27)</td>
</tr>
<tr>
<td>Center of Mass</td>
<td>1.61 (.02)</td>
<td>1.63 (.02)</td>
</tr>
</tbody>
</table>

174 children

Harpstead et al. CHI 2013
Apple App Store, Norway, 2012

Sales

Angry Birds

DragonBox

Outline

- Introduction and motivation
- Discussion: design challenges
- Role of analytics: DOGeometry and RumbleBlocks
- Case study: DragonBox
DragonBox

Image source: Wired
...well played
We Want To Know

Jean-Baptiste Huynh

Patrick Marchal
$3x + 5 = 2$
Large-scale Algebra Challenges

We did it!

EQUATIONS:

390,935

TOTAL EFFORT: 6 months 28 days 2 hours

7 700 000
Likninger løst

DET HENDETE:

36 110 elever løste likninger sammen
1711 klasser deltok i utfordringen
93% oppnådde “mestring” innen 1½ time

We did it!

EQUATIONS:

644,936

TOTAL EFFORT: 9 months 29 days 22 hours
Erna Solberg

Image source: Office of the Prime Minister, Norway
1st and 2nd graders played for 90+ minutes then solved three in-game equations in a row

0 – 25%  
25 – 50%  
50 – 75%  
75 – 100%  

75 – 80  
80 – 85  
85 – 90  
90 – 95  
95 – 100
96% of students who played 90+ minutes could solve three *in-game* equations in a row.
Challenge: transfer to paper

DragonBox: no statistically significant learning gains for solving equations on paper

Long et al. ITS 2014
DragonBox for Programming

with Ian Arawjo, Cheng-Yao Wang, François Guimbretière, Andrew Myers, CHI 2017
Summary

What can game analytics tell us about:

- does audio matter?
- does anyone read tutorials?
- do secondary objectives increase play time?
- what is the optimal level of difficulty?
- can incentives be problematic?
- who pays for games these days and how much?
- what is the impact of game balance?
- is Pokémon GO dangerous?
- can game players contribute to science?
- can people learn useful skills from playing a game?
Summary: Game Mechanics

- Games have:
  - rules
  - actions
  - interactions
  - conflict
  - decisions
Summary: Prototyping

- Generating, sharing, and testing *multiple ideas* leads to better outcomes
- Great way to prototype is with *paper*

Clicks per million impressions

Dow et al. CHI 2011
Summary: Learnability

- Learnability is often the *central design challenge*
  - Developers often overestimate players’ skills
- “Nobody reads and nobody listens”
- Learnability is enabled by:
  - *tutorials* that present information in context
  - an intuitive *user interface*
  - a *level progression* that grows in complexity
  - *learning pathways* that prioritize training of key skills
Summary: Engagement

- Players are driven by *incentives* and *mastery*
- Incentives can affect players differently

Andersen et al. FDG 2011
Summary: Engagement

- Players are driven by *incentives* and *mastery*
- Incentives can affect players differently
- Moderate difficulty seems important

Abuhamdeh and Csikszentmihalyi 2012
Summary: Engagement

- Players are driven by incentives and mastery
- Incentives can affect players differently
- Moderate difficulty seems important, but...
- ... when in doubt, make the game easier

Lomas et al. CHI 2013

Spiel et al. CHI 2017
Summary: Balance

- Key properties of the game’s decision space:
  - Are the starting conditions of the game fair?
  - Does it matter what the player does?
  - Is an action too powerful?
  - Is the outcome known long before the game’s end?
  - Is some strategy useless?
Summary: Polish

- Presentation matters!
- Hard to define exactly
- **Technique:** look at games and analyze polish
- Disney animation techniques help
  - stretch and squash, easing, staging, exaggeration
Summary: Playtesting

- Bias is pervasive
- To overcome, use multiple techniques:
  - Direct observation
  - Think-alouds
  - Question & answer
  - Surveys
- Must read emotions
Summary: Telemetry & Analysis

- Visualization techniques
  - *Burndown charts* can show problems with retention
  - *Heatmaps* can show where problems are occurring
  - *Sankey & state transition diagrams* can show how various groups of players are affected by a problem

- *SQL* is used for storying and querying data

- *Null-hypothesis statistical testing* helps resolve whether differences in A/B tests are due to chance
Why should you take this class?

real-world impact, *this semester*