Kurt Squire
Professor, C&I, UW-Madison
Co-Director, GLS, WID
Wisconsin Institutes for Discovery
Wisconsin Institutes for Discovery

Pharmaceutical Informatics

Optimization

Regenerative Biology

Computational Technology

Wisconsin Institutes for Discovery
Wisconsin Institutes for Discovery

Pharmaceutical Informatics

Regenerative Biology

Medical Devices

Computational Technology

Educational Research

Systems Biology

Optimization

Virology

Wisconsin Institutes for Discovery

Tuesday, September 18, 12
Educational Games that Make Discovery Visible
Experience the thrill of scientific discovery.
Participate in the Making of Science
Serious Games = Games for Learning or Training
Serious Games = Games For Learning or Training

Wrong!!!
Games: 30+ Years of Evolutionary Design

Tens of Millions of Customers

30+ Billion Revenues

Global Culture

Tens of Millions of GPUs

Alternative Inputs

Major Multicore Platforms

Darwinian Business Environment

Games

Serious Games

Games

Serious Games
### Taxonomy of Serious Games

<table>
<thead>
<tr>
<th>Category</th>
<th>Games for Health</th>
<th>Advergames</th>
<th>Games for Training</th>
<th>Games for Education</th>
<th>Games for Science and Research</th>
<th>Production</th>
<th>Games as Work</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government &amp; NGO</strong></td>
<td>Public Health Education &amp; Mass Casualty Response</td>
<td>Political Games</td>
<td>Employee Training</td>
<td>Inform Public</td>
<td>Data Collection / Planning</td>
<td>Strategic &amp; Policy Planning</td>
<td>Public Diplomacy, Opinion Research</td>
</tr>
<tr>
<td><strong>Defense</strong></td>
<td>Rehabilitation &amp; Wellness</td>
<td>Recruitment &amp; Propaganda</td>
<td>Soldier/Support Training</td>
<td>School House Education</td>
<td>Wargames / planning</td>
<td>War planning &amp; weapons research</td>
<td>Command &amp; Control</td>
</tr>
<tr>
<td><strong>Healthcare</strong></td>
<td>Cybertherapy / Exergaming</td>
<td>Public Health Policy &amp; Social Awareness Campaigns</td>
<td>Training Games for Health Professionals</td>
<td>Games for Patient Education and Disease Management</td>
<td>Visualization &amp; Epidemiology</td>
<td>Biotech manufacturing &amp; design</td>
<td>Public Health Response Planning &amp; Logistics</td>
</tr>
<tr>
<td><strong>Marketing &amp; Communications</strong></td>
<td>Advertising Treatment</td>
<td>Advertising, marketing with games, product placement</td>
<td>Product Use</td>
<td>Product Information</td>
<td>Opinion Research</td>
<td>Machinima</td>
<td>Opinion Research</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>Inform about diseases/risks</td>
<td>Social Issue Games</td>
<td>Train teachers / Train workforce skills</td>
<td>Learning</td>
<td>Computer Science &amp; Recruitment</td>
<td>P2P Learning Constructivism Documentary?</td>
<td>Teaching Distance Learning</td>
</tr>
<tr>
<td><strong>Corporate</strong></td>
<td>Employee Health Information &amp; Wellness</td>
<td>Customer Education &amp; Awareness</td>
<td>Employee Training</td>
<td>Continuing Education &amp; Certification</td>
<td>Advertising / visualization</td>
<td>Strategic Planning</td>
<td>Command &amp; Control</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td>Occupational Safety</td>
<td>Sales &amp; Recruitment</td>
<td>Employee Training</td>
<td>Workforce Education</td>
<td>Process Optimization Simulation</td>
<td>Nano/Bio-tech Design</td>
<td>Command &amp; Control</td>
</tr>
<tr>
<td>Learning</td>
<td>Games for Health</td>
<td>Advertise &amp; Sales</td>
<td>Games for Training</td>
<td>Games for Education</td>
<td>Games for Science and Research</td>
<td>Production</td>
<td>Games as Work</td>
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<td>YES</td>
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</tbody>
</table>

| Practice                 | YES              | Unlikely          | YES                | YES                 | YES                            | Unlikely   | Unlikely      |

| Physiological Change     | YES              | Rare              | Unlikely           | Rare                | Rare                           | NO         | NO            |

| Crowdsourcing & Productivity | YES              | Rare              | Unlikely           | NO                  | YES                            | YES        | YES           |

| Measurement & Assessment | YES              | YES               | YES                | YES                 | YES                            | Uncommon   | YES           |

| Awareness                | YES              | YES               | NO                 | Unlikely            | YES                            | NO         | NO            |

| Expression               | YES              | Uncommon          | NO                 | NO                  | Unlikely                       | YES        | NO            |

| Persuasion               | YES              | YES               | NO                 | NO                  | Uncommon                       | NO         | NO            |

| Behavior Change          | YES              | YES               | YES                | Uncommon            | YES                            | NO         | NO            |
## Market Segments

<table>
<thead>
<tr>
<th>Enterprise</th>
<th>Non-Entertainment Users</th>
<th>Retail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instructors &amp; Utilizers</strong></td>
<td>E-Learning</td>
<td>Modeling &amp; Simulation</td>
</tr>
<tr>
<td></td>
<td>Education Software</td>
<td>Serious Games</td>
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<tr>
<td></td>
<td>Game Marketing &amp; Cultural Cues</td>
<td>Serious Stuff Gamers Do</td>
</tr>
<tr>
<td><strong>Game Influenced</strong></td>
<td><strong>Entertainment &amp; Gamers</strong></td>
<td><strong>Actual Game</strong></td>
</tr>
</tbody>
</table>
### Serious Usage Segments

<table>
<thead>
<tr>
<th>Serious COTS</th>
<th>Gamers</th>
<th>Third Party</th>
<th>Developers</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reset Purpose</strong></td>
<td>Wii Exergaming</td>
<td>Curriculum Development</td>
<td>Teaching Guides &amp; Support Forums</td>
<td>Machinima</td>
</tr>
<tr>
<td>Modify Software or Hardware</td>
<td>CounterStrike</td>
<td>Revolution (Neverwinter Nights)</td>
<td>Non-Entertainment Modes of Play</td>
<td>PS3 Folding@Home</td>
</tr>
<tr>
<td>Augment</td>
<td>Guitar Hero Sequencer</td>
<td>Curriculum Development</td>
<td>PowerGrid SmartBrainGames</td>
<td>Linux on PS3</td>
</tr>
<tr>
<td>Serious Games</td>
<td>Virgin Development</td>
<td>XNA Creators Club</td>
<td>Use of Specialized Serious Games</td>
<td>Serious Game COTS &amp; Specialized Serious Game Development</td>
</tr>
</tbody>
</table>

**Serious Games**

- XNA Creators Club
- Indie Development
- Use of Specialized Serious Games
- Serious Game COTS & Specialized Serious Game Development
- Microsoft ESP or Breakaway MOSBE
Games for Education

Traditional Edutainment

Serious Games as “Re-envisioned Edutainment” (non commercial)

Repurposed COTs (see COTs Boggle)

Serious Games as “Re-envisioned Edutainment” (commercial)
Scientific literacy

- 28% of US adults pass basic scientific literacy (Sweden 35%)
- 70% of US can’t understand *NY Times* Science Section
- This masks the true problem (?!)

Miller, 2009
Figure 1: Civic Scientific Literacy in the United States, 1988–2008

On Darwin’s Birthday, Only 4 in 10 Believe in Evolution
Belief drops to 24% among frequent church attenders
by Frank Newport

PRINCETON, NJ -- On the eve of the 200th anniversary of Charles Darwin’s birth, a new Gallup Poll shows that only 39% of Americans say they “believe in the theory of evolution,” while a quarter say they do not believe in the theory, and another 36% don’t have an opinion either way. These attitudes are strongly related to education and, to an even greater degree, religiosity.

Do you, personally, believe in the theory of evolution, do you not believe in evolution, or don’t you have an opinion either way?

- 39% Believe in evolution
- 25% Do not believe in evolution
- 36% No opinion either way
- 1% No answer
So what can we do about it?
Adding to the United States' relatively good showing is Americans' use of informal science education resources, such as science magazines, news magazines, science museums and the Internet.
Contemporary scientific advancements require not just public understanding of science, but engagement and even participation in science.
Public participation in data collection & analysis
How amazing is this: U.S. gamers, playing a protein-folding game called Foldit, have helped unlock the structure of an AIDS-related enzyme that the scientific community had been unable to unlock for a decade.
Can we create a national movement to better involve the public in scientific discovery?
### Games for Education

<table>
<thead>
<tr>
<th></th>
<th>General</th>
<th>Adult</th>
<th>University</th>
<th>High School</th>
<th>Middle School</th>
<th>Elementary</th>
<th>Pre-K</th>
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<tbody>
<tr>
<td>Informal</td>
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<td>Driver Simulators</td>
<td>Pink</td>
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<td>Flight Simulator</td>
<td>Blue</td>
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<td>Civ4</td>
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<td>Project Connect</td>
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<td>Zoo Tycoon</td>
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<td>PBS Kids</td>
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<td>Yellow</td>
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<tr>
<td>Formal</td>
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<tr>
<td>Cisco Binary Game</td>
<td>Red</td>
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<td>Workforce</td>
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<td>Virtual U</td>
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<tr>
<td>Making History</td>
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<tr>
<td>MIT/PBS Labyrinth</td>
<td>Red</td>
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<tr>
<td>GameStar Mechanic</td>
<td>Red</td>
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</tbody>
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- **Serious Games as “Re-envisioned Edutainment” (non commercial)**
- **Serious Games as “Re-envisioned Edutainment” (commercial)**
- **Repurposed COTs**
- **Traditional Edutainment**
# Games for Science and Research

<table>
<thead>
<tr>
<th></th>
<th>Data Collection</th>
<th>Data Visualization</th>
<th>Data Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research</strong></td>
<td>fold.it</td>
<td>GGNViz Forestry Game</td>
<td>Folding @ Home on PS3</td>
</tr>
<tr>
<td><strong>Development</strong></td>
<td>Google Image Labeler</td>
<td>Landing Lights Park in Second Life</td>
<td>Warhawk PS3 Dedicated Server Farm</td>
</tr>
</tbody>
</table>
Games based on cutting-edge discoveries
Initial Findings:

- High interest in content
- Players use images to scaffold material
- Context for interdisciplinary collaboration
pilot study

- n=24
- pre-post, images and text
- images (Mdn = 5.00)
- text (Mdn = 4.00)
- \( W_s = 43.00, z = -2.38, p < .01, r = -.49. \)
CURRENT CAMPAIGN: North America

Location:
La Jolla, CA

Details:
Reverse the Zombie condition by repairing a human heart.

La Jolla, CA

ACCEPT MISSION
Could a game change the national conversation about stem cells?
Work in close collaboration with stem cell scientists
Dr. Yeong:
Start forming a group of Red Mecells, just like you did with the Cells.
**AGGREGATE DATA:**

*Overall Trends*

<table>
<thead>
<tr>
<th></th>
<th>Pre-Post Gains</th>
</tr>
</thead>
</table>
| **Total Gameplay** | 11% average increase  
|(t-test sig = .0098) |
**AGGREGATE DATA: Overall Trends**

<table>
<thead>
<tr>
<th></th>
<th>Game Progress</th>
<th>Pre-Post Gains</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Gameplay</strong></td>
<td></td>
<td>11% average increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(t-test sig = .0098)</td>
</tr>
<tr>
<td><strong>Overall Success Ratio</strong></td>
<td>significant positive correlation*</td>
<td>no significant correlation</td>
</tr>
<tr>
<td></td>
<td>(r = .3254)</td>
<td></td>
</tr>
<tr>
<td><strong>Last Cycle Success Ratio</strong></td>
<td></td>
<td>significant positive correlation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(r = .3219)</td>
</tr>
<tr>
<td>*n = 39, d = .310</td>
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</tbody>
</table>
Trails Forward

Prof. Michael Ferris
Conservation Conversation Group
Ben Shapiro
Adam Mechtley

Tuesday, September 18, 12
Conserve: Conservation Conversation Group

Members

- **Volker Radeloff**  Forest Ecology and Land Management (Convenor)
- **Jennifer M. Alix-Garcia**  Agricultural and Applied Economics
- **Murray Clayton**  Plant Pathology and Statistics
- **Michael C. Ferris**  Computer Sciences
- **Erika Marin-Spiotta**  Geography
- **Curt Meine**  The Aldo Leopold Foundation
- **Anna M. Pidgeon**  Forest and Wildlife Ecology
- **Francisco Pelegri**  Genetics
- **Adena Rissman**  Conservation Policy and Management
- **Timothy Van Deelen**  Forest and Wildlife Ecology
- **Jake Vander Zanden**  Zoology

2010 Lecture Series

Location of lectures is Russell Labs. Normal time for lectures is Wednesdays at 1:30pm.

- **Adena Rissman (March 10, 2010) (pdf)**
- **Michael Ferris (March 10, 2010) (pdf)**
- **Francisco Pelegri (March 24, 2010) (pdf) (ppt)**
- **Jake Vander Zanden (March 24, 2010) (pdf) (ppt)**
- **Murray Clayton (April 14, 2010) (pdf)**
- **Anna Pidgeon (April 14, 2010) (pdf)**
- **Conservation Games (October 7, 2010) (pdf)**
Game World

Vilas County, WI
963,976 square single acre tiles
(1,352 x 713 grid)
Core Game Cycle

Buy & Sell Property
Lobby the State for Roads
Lobby the State for Zoning Changes
Developers

- Bulldoze land
- Build Homes
- Build Factories
- Enhance Properties (e.g., Solar Panels)
Land Model

3x3 acres
1 Megatile
Ecologists
Ecologists

General Public
Games that let you discovery the joy in helping someone.
What if You Had Cancer?
Symptoms
Symptoms

Imaging
Symptoms
Imaging
Diagnosis
Symptoms
Imaging
Diagnosis
Treatment

“Cut Poison Burn”
Imaging
Diagnosis
Breast Cancer

Hurkmans et al. (2001)

17.5% variation
Lung Cancer

Factor of 2

Senan et al. (1999)
Cervical

3-4x variation

Treatment
This is not good for patients.
Imagine instead....
Diagnosis
Diagnosis
Imagine getting not a second or third opinion, but a doctor working with 2 million opinions.
Anatomy Pro-Am

Gameplay teaches about anatomy, cancer, and medical careers.

Gameplay improves clinical practice.
SINGLE PLAYER PROTOTYPE

Symptoms
Imaging
Diagnosis
Treatment

Tuesday, September 18, 12
Could anything mentioned in my notes on Mr. Rey have contributed to his cancer?
Would kids play this?
Will they learn anything?
Exploratory Study

Participants
* 69 students
* Ages 12 to 20

Format:
1. Pre-test
2. Oncology
3. Post-test
What does a radiologist do?
Open-ended, $\chi^2 (1, N = 69) = 38.03, p < .001$

Pre Correct: 28, Post Correct: 68
Contouring a cancerous tumor
\(\chi^2 (1, N = 69) = 17.46, p < .001\)

Pre Correct: 14, Post Correct: 39
What is difficult about radiotherapy?

\[ \chi^2 (1, N = 69) = 9.03, p < .001 \]

“It is hard to keep from exposing healthy tissue to radiation beams”
Playing APA taught me about treating cancer.

χ² (2, N = 69) = 38.17, p < .001

Observed: 46, Expected: 23
Playing APA taught me about contouring cancerous tumors

$\chi^2 (2, N = 69) = 37.13, p < .001$

Observed: 46, Expected: 23
Students indicated a **highly significant increase in interest medical professions** ($M = 2.93, SD = 1.38$) compared to pre-gameplay ($M = 2.58, SD = 1.25$), $t(69) = 4.11$, $p < .001$.
With training, I could be a good doctor.

Females’ indicated a significant increase in future medical/professional confidence ($M = 3.89$, $SD = 1.16$) as compared to pre-game-play ($M = 3.48$, $SD = 1.37$), $t(27) = 2.28$, $p < .0125$
Radiologists & Doctors

Medical Training

General Public

Children & Youth

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Anatomy Browser

Description
Anatomy Browser is a human anatomy catalog which allows you to peel away layers of the body and identify muscles, organs, and systems of the body in full 3D. With the ability to adjust the transparency of each layer, you'll be able to easily identify the relationship of organs to each other as well as their names!

Education Research Challenge Area at the Morgridge Institute for Research Web Site
Anatomy Browser Support

iPad Screenshots

1K downloads in 3 days
Radiologists & Doctors

Medical Training

General Public

Children & Youth

Tuesday, September 18, 12
How might we assess learning?
CyberStem
Safe Sandbox
Safe Sandbox
Safe Sandbox → Authentic Participation

Consumer
Creating spaces to reimagine public participation in science