Augmenting Learning and Augmenting Reality
Handheld Simulation Games for Learning
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http://education.mit.edu/ar
TEP Pedagogical Frameworks

• **What kind of learning environments?**
  • Create highly engaged, motivated students
  • Provide immersive environments, relevant problems
  • Facilitate collaborative, project-based learning
  • Game-like, active, “Hard Fun”
    • A teacher heard one child using these words to describe the computer work: "It's fun. It's hard…" I have no doubt that this kid called the work fun *because* it was hard rather than in *spite* of being hard. [S. Papert, 2002]
  • Applicable to *formal* and *informal* settings, extending learning beyond walls of the school, beyond hours of the school-day
Why Games?
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- Games model the way that “good” learning happens
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• Need new technologies to teach new ideas
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• Games model the way that "good" learning happens
• Need new technologies to teach new ideas
• The gamer generation is growing
Learning From Games
Learning From Games

Video games (even violent ones) model good learning

What Video Games Have to Teach Us About Learning and Literacy (Gee)
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Got Game (Beck and Wade)
• People who grew up playing games are better adapted to the modern workplace
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Everything Bad is Good for You (Johnson)
- Games involve critical thinking and problem solving - despite their image as “mindless”
Mobile Games
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- Rise of mobile platforms for video games
  - Game Boy, PSP, Cell Phones
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- MIT Projects
  - *Participatory Simulations* - Peer to Peer
  - *Augmented Reality* - Location-based
Designing Mobile Games
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• Hardware
  • Powerful connected devices
  • Many capabilities Off The Shelf
Designing Mobile Games

- **Hardware**
  - Powerful connected devices
  - Many capabilities Off The Shelf

- **Implications**
  - Portability
  - Social Interactivity
  - Context Sensitivity
  - Connectivity
  - Individuality
Designing Mobile Games

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- Easy to implement and scale (COTS)
Learning Goals

• K-16 - 21st Century Skills
  • Engage in authentic science
  • Foster collaborative learning and communication
  • Capitalize on game play motivation
  • Allow role playing “near” actual roles
  • Solve complex problems with complex solutions

• Informal Education
  • Encourage deeper and broader interaction
  • Connect with real surroundings
  • Connect and collaborate with others

• Training
  • Promote teamwork and collaboration
  • Facilitate role playing
  • Provide new perspectives on real problems
  • Integrate real problems into real environments
  • Allow safe play
Games “in” School?
Games “in” School?

- Integrate them into life
  - Play anytime and anywhere
  - Integrate physical and social context
- Build on 21st century skills
Augmented Reality

Computer simulation on handheld computer triggered by real world location

- Combines physical & virtual world contexts
- Embeds learners in authentic situations
- Engages users in a socially facilitated context
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- Terminology
  - Pervasive or Ubiquitous Gaming
    - Time and Space?
Augmented Reality?

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- Immersive helmets
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Terminology
- Pervasive or Ubiquitous Gaming
  - Time and Space?
- Hybrid Reality
  - Mixing technology and real space
Helmets v. Handhelds
Helmets v. Handhelds

• **Light augmentation**
  • *Providing a small amount of “augmented” information. The environment and real people are integral and “real”.*
Helmets v. Handhelds

• **Light augmentation**
  • Providing a small amount of “augmented” information. The environment and real people are integral and “real”.

• **Heavy augmentation**
  • The environment is used as a physical way of navigating through virtual space. Environment can represent anything.
Heavy v. Light

- *Imagine that National Mall is…*
Heavy v. Light

• *Imagine that National Mall is…*

Contaminated with a Toxin
Heavy v. Light

- Imagine that National Mall is...
- Contaminated with a Toxin
- An Underwater Aquarium
A Location-Based Experience

- **Uses GPS** (Global Positioning System) outdoors or **Wi-Fi positioning indoors**…

As participants move, their Pocket PCs know their **real location** and provides location-specific information.
AR: Environmental Detectives

- First Example - Part of G2T
- "Environmental Detectives"
  - Players briefed about rash of local health problems linked to the environment
  - Need to determine source of pollution by drilling sampling wells, interviewing virtual witnesses
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Environmental Detectives

MIT Comparative Media Studies Department
MIT-Microsoft Games-to-Teach Project

presents
Why not use a virtual environment?

VS.

• We can make multiplayer online games that recreate the locations and problem-solving in AR games, BUT
• Communicating face to face is different from online.
• Ability to use the environment differs
• Different criteria are applied in decision-making
Outdoor AR: Example

- **Large Scale (Outdoors)**
- **Example - Charles River City**
  - **Scenario** - Team of experts brought in to investigate mysterious health problems in Boston two weeks before the World Series (DNC, etc.)
  - Structured around **role dependent collaboration**
  - Designed for education and training
Outdoor AR: Features

- Scenarios can include one or multiple player roles.
- Participants interview virtual characters by walking to their real world location (audio, video, images and text).
- Collect data from underlying models using simulated equipment and gather information from items within the game.
- Gates and Checkpoints allow participants in outdoor simulations to enter real buildings.
- Collect evidence for optional in-game conclusions or to prepare for off-line discussion.
Outdoor AR: Knowledge Building Communities
AR Games’ Portability & Customization
AR Games’ Portability & Customization

Across wide range of subjects…

- **Public Health/Disease Outbreak** (Charles RiverCity & Avian Bird Flu)
- **Forensics** (Mad City Murder)
- **Historical Exploration** (Battle of Lexington)
- **Mathematics** (Alien Contact)
- **Economics** (Hip-Hop Tycoon)
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...across locations

- Local Communities (e.g., geographical tours)
- Schools
- Museums
- Science Centers
- Zoos/Nature Conserves
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...across locations
- Local Communities (e.g., geographical tours)
- Schools
- Museums
- Science Centers
- Zoos/Nature Conserves

...and across time
- Beyond normal “class time”
- Over extended period of time
Outdoor AR: In Schools

- Teaching math and literacy to middle school students in Milwaukee, Madison and Boston
- Teacher-customized (using templates) or teacher-designed games
- Moving towards student-designed games
- Authoring toolkits allow customization of a simulation’s location, content and timescale.
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StarSchools

- **AR Simulation Games for Mathematics and Literacy Learning with Emerging Mobile Technologies**
  - **UW Madison / MIT / Harvard University**
Outdoor AR Customization
Outdoor AR Customization

- Map-based tool
Outdoor AR Customization

- Map-based tool
- Grab map from Google Maps
Outdoor AR Customization

- Map-based tool
- Grab map from Google Maps
- Insert into map and GPS coordinates into game
Outdoor AR Toolkit

- Facilitates thinking about roles, data, and gameplay through interactive design.
Moving Indoors

• Indoor game played at the Boston Museum of Science
• Used 802.11 for positioning
• Defining roles to enhance collaboration
• Introducing an element of time to make it feel more like a game
• Solving a mystery using scientific information from the museum
Mystery @ The Museum

Analyze

Communicate

Investigate

Decide

Attention Museum Staff! The Tamarin monkeys have been safely returned to their room.
Mysterious Game Play

Parents and Kids Collaborating

Fostering Collaboration Through Roles

Collecting Virtual Samples

Using Contextual Information
M@M Collaboration

• Collaboration Across Roles
  • Boy 3: Have you been to the mummy?
  • Mom 2: Yes we went there.
  • Boy 3: They have to go there since they're the biologist. It is upstairs…
  • Boy 1: Let's give you [the Technologist] the splinters so you can look at them with the microscope.
  • Mom 1: We got the hobo code but we can't fully decode it. What do you think this means? [beams to other groups so that they can all look at the picture]
Participant Reactions

• Deep engagement across real and virtual

• Parent-child
  • Parent - "this is the longest substantive interaction I've had with my son in years without fighting."
  • Child - "my mom actually had a reason to be here [to help me figure out part of the game]".

• Girls
  • “I’m not the techie in the family and often feel left out by technology, but during this experience, I really got it."
AR Indoors: Outbreak @ MIT

• **Outbreak @ MIT (client-server model)**

  • Participants must find the source of a mysterious disease outbreak at MIT and contain it before it gets out of control.

  • **Client-server** architecture allows “one world” with **underlying models** and more realistic feel.

  • Tested with educators and epidemiologists for learning and training
Outbreak @ MIT: Scenario

• The Department of Public Health has been investigating a recent flight from Chicago to Boston. Several passengers have become ill with a respiratory disease which may be SARS and are being housed in a Boston medical facility.

• Have two passengers associated with MIT contracted or spread the disease?
  • Cindy Hsiao, a visiting student
  • Quint Grandville, an MIT employee
Outbreak @ MIT: Game Design

- **Locations**
  Virtual characters and items are spread around MIT buildings

- **Time**
  30 mins of *real time* = 1 wk *game time*

- **Disease transmission**
  - Probability of infection depends on the amount of time you spend in a room with an infected player or NPC.
  - Infection causes your “antigen level” to increase and your health level to drop.
  - Multiple disease models are built into the game.

- **Multiple Roles**
Feedback through Models

- **Detailed Systems Model - Disease**
  - Virus spread between individuals (real and NPC)
  - Virus load within individuals

- **Medical Apparatus**
  - Protective gear
  - Medicines
  - Samples

- Allows players to **assess their own success within the game**

- Enhanced **game play and collaboration through interconnectedness**
• Public Opinions of Science using Information Technologies
• Collaboration between MIT, MIT Museum and the Boston Museum of Science
• Engage public in relevant and scientifically based controversies
• Funded by Microsoft iCampus
• Builds off of contextual decision-making seen in earlier AR
Overview

• POSIT’s goals are to help people:
  • **Explore** complex scientific ideas
  • **Examine** current science and technology controversies
  • **Engage** in a rich discussions using scientific evidence
  • **Understand** alternative viewpoints through role-playing
  • **Reflect** on the dynamics of opinion change in themselves and in a group
  • **Gain** a deeper sense of the relevancy of science, particularly among underserved audiences
Pedagogical & Intellectual Basis

• Overview
  • Builds off of rich history of classroom dialogs in the form of Model UN, Mock Trials, Town Hall Debates, etc.

• Related concepts
  • Citizens Juries
  • Consensus Conferences
  • DECIDE
1st POSIT Game Overview

Game is focused around a single yes/no policy question (fictionalized). For example, “Should we build a biohazard level 4 research facility in our community?”

- **Briefing** - Potential biohazard facility in Boston
- **Roles** - Playing realistic roles from scientist to resident
- **Initial Opinion** - Opinions “in role” are registered
- **Collecting Data** - Players collect information from virtual characters, and real artifacts/places
- **Sharing Opinions** - Players share information that they have collected to convince others of their [character’s] point of view
- **Influencing Others and Changing Opinions** - Influence key individuals to sway the vote
- **Final Decision** - voting
POSIT Walkthrough
POSIT Walkthrough

- Players are **assigned roles** (12-15) and receive a briefing
  - A decision must be reached on whether or not to build the research facility.
  - Every role has a story (e.g. out of work biotech, concerned parent)
- Register initial opinions
- Team up with allies and target the opposition
POSIT Walkthrough
POSIT Walkthrough

- Players continue to collect information, and change their own opinions accordingly.
POSIT Walkthrough

- Players continue to collect information, and change their own opinions accordingly.
- Players also interact with each other and use their evidence that they have collected to sway players their way.
POSIT Walkthrough

• Players continue to collect information, and change their own opinions accordingly.
• Players also interact with each other and use their evidence that they have collected to sway players their way.
• Players constantly monitor the way the group is leaning and target particular other players with information that they collect.
Should MIT build a BSL-4 laboratory?
Players in the end vote (based on their final opinions) on the issue at hand.

In a discussion following the game, the facilitator leads a discussion around the real issue, and reflection on decision-making.
Preliminary Research Results

• Students report that the rating system helped them improve their arguments:
  - it “made you realize some things did not back your argument as much as you thought.”
  - it “made people have to back up their ideas.”
  - it “[made] your argument stronger and efficient.”
Preliminary Research Results

• **Perspective taking:**
  
  “reading the messages from the characters helped me view different perspectives of these characters like the firefighter, Molly [etc].”

• **Location matters:**

  “I saw the spot where the building was set to be built on and it was very scary how many students and people walked by it constantly.”
Participatory Simulations

- Engage learners in computer mediated simulations
- Provide rich learning experiences where technology and social interaction are key
- Use relatively simple and cheap technologies (Palms<$100) and IR peer to peer communication
- Virus, Genetics, Networks…
Palmagotchi - Anytime Anywhere

- Virtual pets with Biology
- Birds and flowers
  - Like Darwin’s Finches in the Galapagos
  - “Every man is an island”
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Palmagotchi Foraging

• Player 1

• Player 2
Palmagotchi Foraging

- Player 1
- Player 2

Available partners:

- eric

Select Partner

Cancel
Palmagotchi Foraging

- **Player 1**
  - Select Partner
    - Available partners:
      - eric

- **Player 2**
  - myWorld QUARTZ
    - Player | Wants To
    - judy | Forage

- Accept | Reject | Reject All

Palmagotchi Foraging

- Player 1

- Player 2
Palmagotchi Foraging

- **Player 1**
  - Select Partner
  - Available partners:
    - Hazel
      - Pollen: 38
      - Nectar: 51
      - Color: Red
      - Pollen Type: 9
      - Flower Length: 2
      - Production Rate: 10
      - Heartiness: 8
    - Forage

- **Player 2**
  - myWorld - Interact
  - Player: judy
  - Wants To: Forage
  - Accept | Reject | Reject All
Palmagotchi Foraging

- Player 1
  - Select Partner
  - Available partners:
    - Hazel
      - Pollen: 38
      - Nectar: 51
  - Hazel
  - Little One
    - Age: 6
    - Mature: +Pollen
      - Energy: 183
      - Clutch Size: 2
      - Speed: 10
      - Metabolism: 40
      - Feather Type: 6
      - Featheriness: 5
      - Beak Length: 3
      - Color Preference: Red

- Player 2
  - myWorld - Interact
  - Judy
  - Forage
  - Accept
  - Reject
  - Reject All
Palmagotchi Foraging

- **Player 1**
  - Select Partner
  - Available partners:
    - Hazel
      - Pollen: 38
      - Nectar: 51
  - Forage

- **Player 2**
  - Interact
  - Your flowers were pollinated and have produced offspring!
  - Continue
Palmagotchi Foraging

- **Player 1**
  - Select Partner
  - Available partners:
    - Hazel
      - Pollen: 38
      - Nectar: 51
  - Little One
    - Age: 6
    - Mature + Pollen
      - Energy: 183
      - Clutch Size: 2
      - Speed: 10
      - Metabolism: 40
      - Feather Type: 6
      - Featheriness: 5
      - Beak Length: 3
      - Color Preference: Red
    - Forage
    - Mate
    - Cancel

- **Player 2**
  - myWorld - Interact
  - myWorld - Quartz
  - myWorld - Flowers
  - myWorld - Overview
  - Birds
    - Safflower
      - Age: 1
    - Lucene
      - Age: 1
    - Kangaroo
      - Age: 1
    - Lilac
      - Age: 0
Palmagotchi Mating

• Player 1

• Player 2
Palmagotchi Mating

- Player 1
- Player 2
Palmagotchi Mating

- **Player 1**

  - Garcia
    - Age: 5

  - Gershwin
    - Age: 6

  - Squeaker
    - Age: 6

- **Player 2**

  - eric
    - Mate

  - Accept
  - Reject
  - Reject All
Palmagotchi Mating

- **Player 1**

  ![](image1)

  **Gershwin**
  - Age: 6
  - Mature
  - Energy: 128
  - Clutch Size: 2
  - Speed: 71
  - Metabolism: 85
  - Feather Type: 0
  - Featheriness: 1
  - Beak Length: 4
  - Color Preference: Orange

  ![myWorld - Mating interface for Player 1]

- **Player 2**

  ![](image2)

  **myWorld QUARTZ**
  - Player: eric
  - Wants To: Mate

  ![myWorld - Interaction interface for Player 2]
Palmagotchi Mating

- Player 1
  - This is your bird
  - Garcia

- Player 2
  - myWorld - Interact
  - You birds have mated and produced offspring!
Palmagotchi Mating

- Player 1
- Player 2
Palmagotchi Mating

- Player 1

- Player 2
Palmagotchi Risks

- Cold spells
- Being eaten while foraging
- Poorly chosen flowers or mates
- Learn to maximize survival
Palmagotchi Research

- Just completed first implementation
- Classes of high school biology students
- Playing Palmagotchi over three days within school (approx 7 hours per day)
- Using in-class time to discuss data and plan strategies
- Tying back to genetics, evolution, behavior, and ecology
Palmagotchi In Action
Palmagotchi In Action

• In class
Palmagotchi In Action

- In class
- Out of class
Palmagotchi Results
Palmagotchi Results

- Caring about creatures ("sort of alive" - Turkle)
  - Led to pursuit of strategies for success and learning about evolution
- Evolution is dynamic and depends on the environment
- Demand for "mini-games"
Thanks to:
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• education@mit.edu
• http://education.mit.edu/ar