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Simulations and Games for Education

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Overview

- Designing Simulations and Games: Cognition & Skills
  - Conceptual Design
  - Educational Objectives
  - Mechanics
  - Design Principles

Cognitive Design Factors

Cognitive Design Factors

Cognitive Design Factors

Educational Games
Presentation of a game related to today’s topic
(1 group - 5min.)
Learning from Animations and Simulations

Learning Game Design Model (Plass, 2010)

Analyse Requirements
Overall Learning Approach
- Function of Game
  - Prepare Future Learning, Teach Content, Practice Content, Teach 21st Century Skills
- General Level Designs from Learning Perspective
- Learning Progressions within Levels
- Assessment Requirements

Analyze Requirements
- Learning Objectives
- Profile of Learners
- Setting of Use (formal, informal)
- Context / Subject to be covered
- Type of knowledge desired as outcome (what test is used?)
- Competitive Projects

Overview

Designing Simulations and Games: Cognition & Skills

- Conceptual Design
  - Design Model
  - Conceptual Approach
- Educational Objectives
- Mechanics
- Design Principles

Introduction

Overview

- Educational Games

Introduction
Gaming Ideas
- Overall Conceptual Design
- Game Genre
- Essential Game Mechanics
- Essential Rules
- Incentive System (Points, Narrative, ...)
- Assessment Mechanisms

Formalize Design
- Integrate Game Design and Learning Design
- Link Game Mechanics to Educational Objectives
- Link Visual Representations to Educational Objectives
- Develop Design Document

Test Ideas
- Repeat Until <Happiness>
- Prototype
- Play Test
- Revise

Formative Evaluation
- Does the game deliver what it was meant to?
- All levels of design
- Play Test
- Outcome Assessment

Conceptual Approach
- Situated Learning Matrix–Experience (Gee, 2006)
  - Goals
  - Interpretation
  - Feedback
  - Explanation
  - Practice
  - Social Interaction

Cognitive Design Factors
- Conceptual Approach
  - Define Overall Learning Approach
Overview

- Designing Simulations and Games: Cognition & Skills
  - Conceptual Design
  - Educational Objectives
    - Higher-level objectives
      - Evidence-based Design
    - Design Principles

Cognitive Design Factors

- Higher-Level Objectives
  - State Objectives on a conceptual level
  - Based on User Analysis/Needs Assessment

Presentation

- Presentation of a game related to today’s topic
  (1 group – 5min.)
  - Learning from Animations and Simulations

Conceptual Design

- Educational Objectives

  - State Objectives on a conceptual level
  - Evidence-based Design

  - Define educational goals of game
  - Define outcomes (e.g., desired knowledge of learners)
  - Define and identify acceptable evidence for learning
  - Design activities to learn and provide evidence of learning

Cognitive Design Factors

- Evidence-based Design

  - Define educational goals of game
  - Define outcomes (e.g., desired knowledge of learners)
  - Define and identify acceptable evidence for learning
  - Design activities to learn and provide evidence of learning

Mechanics

- Learning Mechanics
- Game Mechanics
- Assessment Mechanics
Overview

- Designing Simulations and Games: Cognition & Skills
  - Conceptual Design
  - Educational Objectives
  - Mechanics
  - Design Principles
    - Cognitive Design Factors
    - Critical Elements of Game Design

Cognitive Design Factors

- Cognitive Design Factors
  - Design recommendation based on information processing and knowledge construction aspects of learning

Information Design: Representation
- Spatial, Temporal Contiguity
- Cueing, Color coding
- Iconic representations more effective, especially for learners with low prior knowledge (Plass et al., in press)
**Cognitive Design Factors**

**Interaction Design:** Exploration
- Content Manipulation: Exploratory environments more effective than worked-out examples, especially for learners with high levels of executive functions (Homer, Plass et al., in press)

**Pedagogical Design**
- Guidance is needed in exploratory environments (Mayer 05)
- Reflection increases comprehension
- Explanatory Feedback better than corrective feedback
- Design needs to be task-appropriate

**Research Findings**

**Molecules & Minds (IES)**

**Educational Approach**
- Goal: Compare Discovery Learning vs. Direct Instruction
- Participants: 93 NYC high school students, 11th grade
- Design: 2 x 2 factorial design (Icon vs. No Icon, Direct Instruction vs. Exploration)

**Results:**
- **Comprehension:** Simulation Exploration > Direct Instruction (d = .47) (Plass et al., 2007)
- **Transfer:** Level of executive functions moderated the treatment effect:
  - Higher levels of executive functions:
    - Exploration > Direct Instruction (d > 2.71)
  - Lower levels of executive functions:
    - Failed to reach significance (p = .087)
    - Trend: Direct Instruction > Exploration (Plass et al., 2007)
**Research Findings**

**Simulation Efficacy**
- **Results - Texas (rural)**
  - Pre-test revealed lower prior knowledge than NYC students.
  - Simulation group had increased knowledge transfer, self-efficacy, and graphing skills.
- **Results - NYC**
  - Pre-test revealed lower prior knowledge than Texas students.
  - Simulation group had increased comprehension, transfer,
  - Higher student engagement in classes using simulations.

*(Lee, Plass, & Homer, 2006; Plass et al., 2009)*

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**Factor Reactor Study (G4LI)**
- **Play Mode**
  - **Results**
    - Situation Interest: Solo play was less interesting than competitive and collaborative play. No difference between 2-player modes.
    - Post-game Performance: Competitive game play resulted in better performance than solo and collaborative game play.
    - Math Fluency: Only solo play was superior to competitive play.

*(Plass et al., 2010)*

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**Representation Format**
- **Results**
  - Adding icons increases comprehension, especially for learners with low prior knowledge and for complex materials.

*(Lee, Plass, & Homer, 2006; Plass et al., 2009)*

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**Molecules & Minds (IES)**
- **Simulation Efficacy**
  - **Goal:** Determine efficacy of simulations integrated in high school classrooms.
  - Participants: 361 high school students (15 classrooms) in NYC,
    267 high school students (29 classrooms) in rural Texas.
  - Design: Simulation integration vs. no-simulation use (same lesson plan).
  - Data: Pre/post learning measures, video observations, observer protocols.

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**Research Findings**

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*(Plass et al., 2010)*

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**Cognitive Design Factors**
- **How to preserve the ‘gameness’ of games**
Design your educational game! (project teams, 30-45min)

- Design your educational game from a cognitive perspective
  - Conceptual Approach
    - Higher-level Objectives
    - Desired Outcomes (learning, skills)
    - Activities/Game Mechanics
    - Consider Cognitive Design Factors and essential elements of game design