

Human-Centered Development of Games- Based Learning Environments



<http://www.peda.net/veraja/jyu/ac/agl/>



University of Jyväskylä

- Today there are nearly 15000 degree students, and exchange students from some 150 foreign universities. <http://www.jyu.fi/indexeng.shtml>
- Seven Faculties, several separate Institutes
- Institute for Educational Research
<http://ktl.jyu.fi/ktl/english>
- Agora Center: Human Technology Center
<http://www.jyu.fi/agora/en/>



Agora Game Lab

Agora Center

Agora GameLab is a multi-disciplinary research and development centre for digital games and gaming culture.



<http://www.peda.net/veraja/jyu/ac/aql>

Main tasks

- Coordination of knowhow and activities in the area of digital games in the University of Jyväskylä
- Research on digital games
- Game Design and Development
- Seminars
- Student network
- Collaboration with companies
- Participation in national and international networks



Human-Centered Development of Games-Based Learning Environments (2005)

- Leader of the research group: Ph.D., docent Marja Kankaanranta (*Educational sciences*), Institute for Educational Research & Agora Center
- Professor Pekka Neittaanmäki (*Mathematical information technology*)
- Researcher, M.Ed. Elina Hämäläinen (*Teacher education*), Institute for Educational Research
- Researcher, M.Ed. Jenni Kaisto (*Educational sciences*), Agora Center
- Research assistant Juha Karvonen, Agora Center (*Information systems*)
- Researcher, M.Sc. Antti Kirjavainen (*Mathematical information technology*), Agora Center
- Researcher, M.Sc. Tiina Nevanpää (*Science education*), Institute for Educational Research
- Researcher, M.Ec. Tuula Nousiainen (*Information systems*), Agora Center
- Trainee Heikki Nevala (*Mathematical information technology*), Agora Center & Department of Mathematical Information Technology
- Trainee Jukka Miettinen (*Mathematical information technology*), Agora Center & Department of Mathematical Information Technology

Partners

- Students and teachers in various schools and kindergartens (e.g. in Jyväskylä, Joutsa, Leivonmäki, Tampere)
- Faculty of Information Technology (project studies)
- University of Hong Kong: Nancy Law (GameWorld)
- University of Berkeley: John Canny (Human-centered design)
- Embassy of Finland in Washington, D.C.
- University of Twente: Joke Voogt (development research)
- CoEduGame project (Tekes - National Technology Agency of Finland): Veikkaus Oy, TeliaSonera, MobileMirror, Innosonic Oy, PrimeChess Oy
- Jyväskylä Science Park



Development of Online and Mobile Learning Games

The aim of the research group is to develop online and mobile learning games / game-like learning environments, and study the possibilities provided by multi-channel technology for learning games.

The goal is to develop games and procedures that can be distributed both nationally and internationally through various channels.



Research Questions

- What are the essential factors in the design, development, testing, and usability analysis of educational games?
- How can users be involved in game design?
- What are the essential attributes of learning games / game-like learning environments?
- How are game design processes carried out in the development of different types of games
- What are the effects of game play on learning?

Multi-disciplinary perspectives

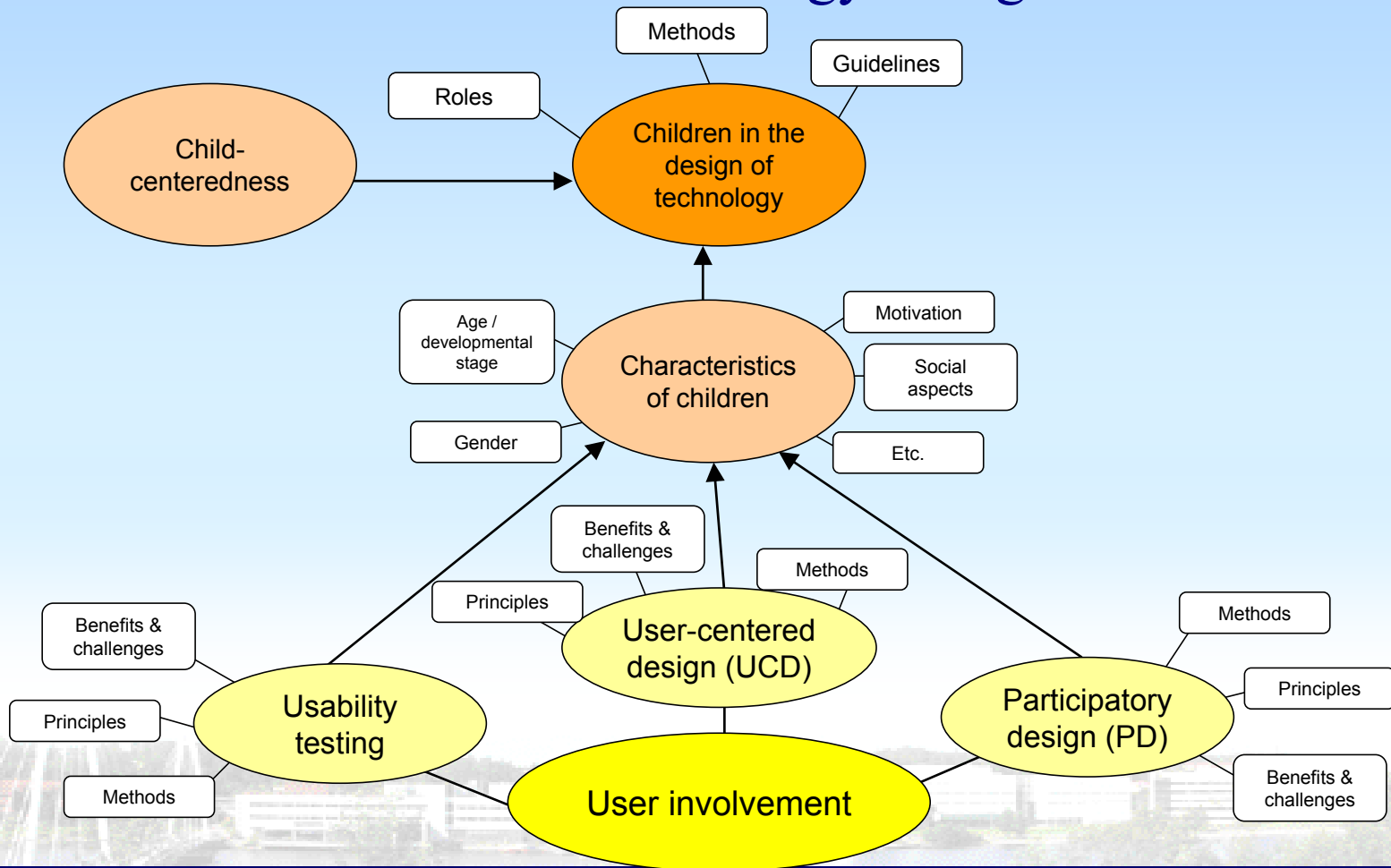
- User-centered, participatory design
- Software engineering
- Game design
- Pedagogical design
 - Content development
 - Pedagogical game script
 - Authentic assessment
- Mobility



User-Centered, Participatory Design

- The aim is to develop and analyze user-centered design methods and principles that can be applied in the design of learning games.
- How can user participation be successfully put into practice in learning game design projects?
 - What are the benefits and challenges of user participation?
 - What are the special characteristics of user participation in the context of learning game design?
 - How can users' participation promote the 1) educational, 2) motivational, and 3) game-like aspects of the game and 4) the usability of the game?
 - In which phases of the design process is users' participation especially needed?
 - How can users' feeling of empowerment be supported?
 - Which methods promote the active participation of users 1) in the innovation of requirements, and 2) in the evaluation of their implementation?
 - How can users' participation be realized within the limits of the constraints in resources?
- These questions are studied during the development of different game prototypes.

Children and Technology Design





Pedagogical Design – Research on Learning

Designing a game / learning environment that supports learning

- Pedagogical choices and technological implementations
 - E.g. site structure, presentation forms, layout, functionality
 - pedagogical game script

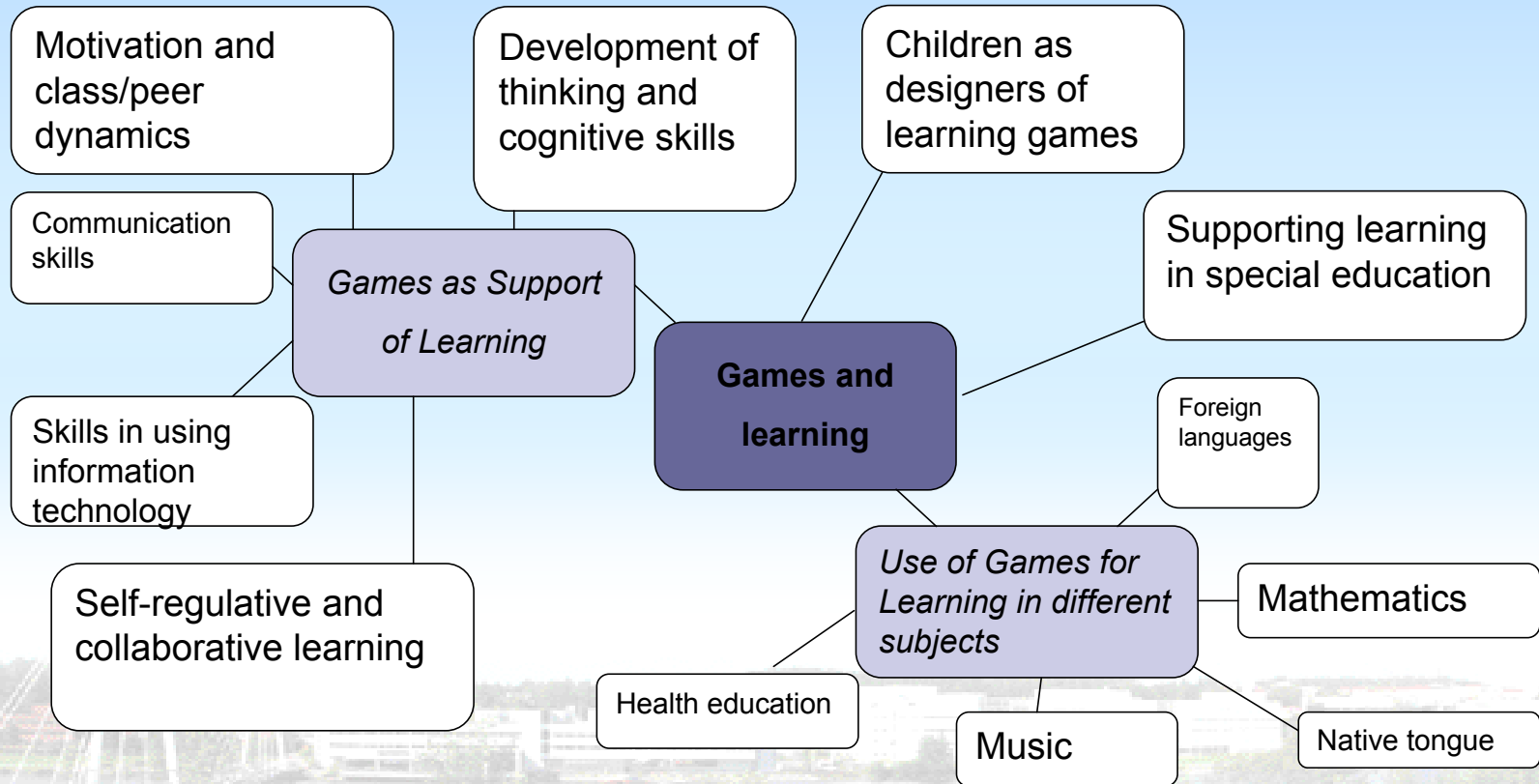
Materials and contents that support learning

- Contents, goals, target group
 - E.g. assignments, games, animation, text

Supporting teaching and learning: Didactical basis and educational solutions

- Motivation
- Recalling what has been learned
 - E.g. experiences of success, possibility to choose
- Assessment of learning and deepening what has been learned
 - E.g. giving and receiving feedback
- Instructions

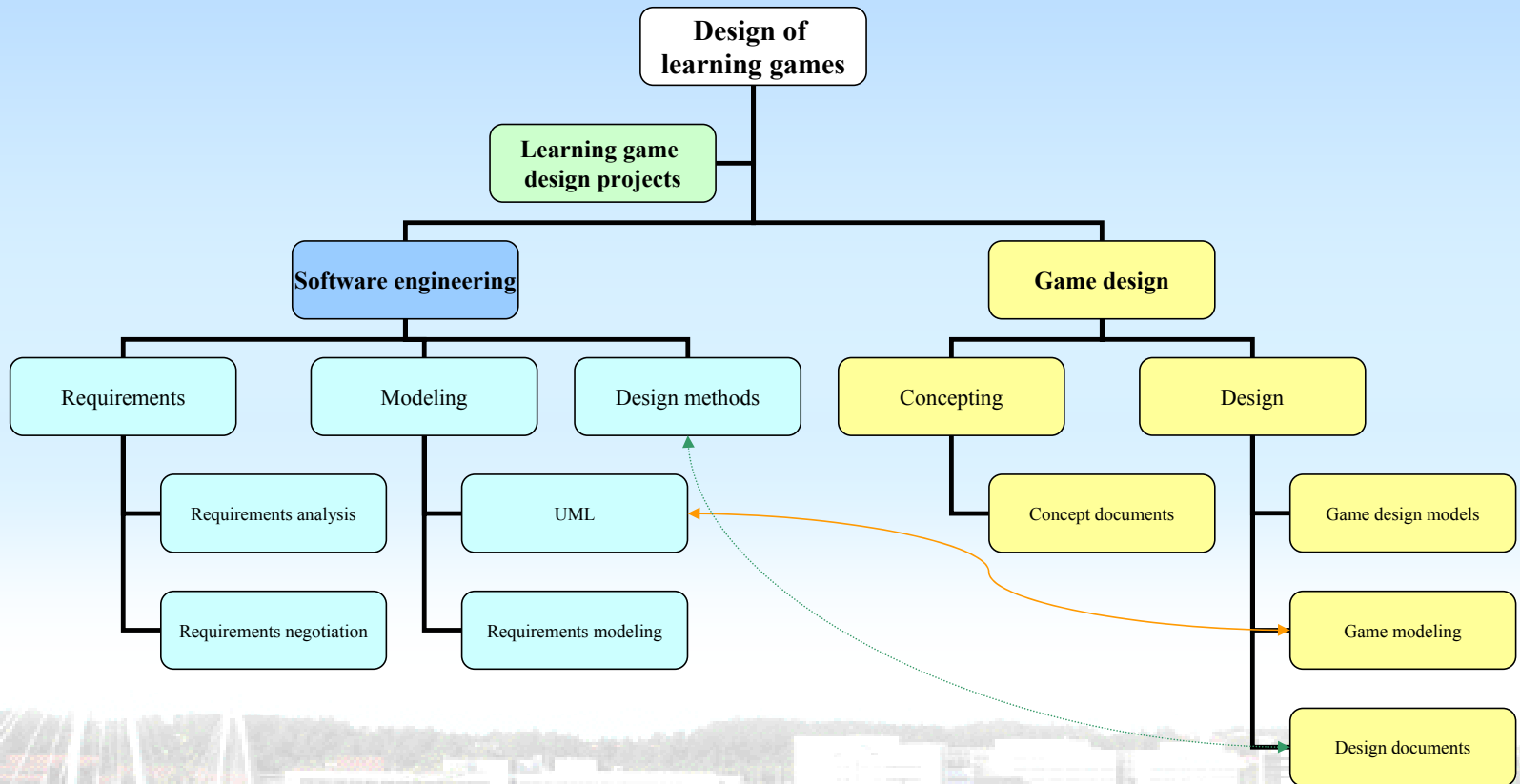
Research Areas of Games-Based Learning



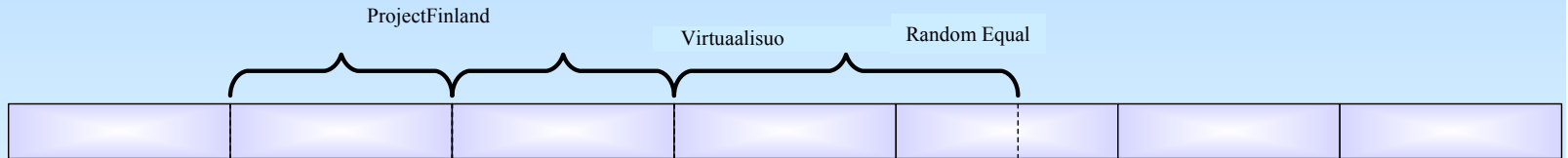
Software Engineering and Game Design

- The aim is to develop and analyze software engineering and game design methods and principles that can be applied in the design of learning games.
- How do we design and develop a learning game that meets the expectations?
 - Which software engineering methods are best suited for the design of learning games?
 - How can software design methods support learning game design that is carried out as multidisciplinary team work?
 - How can a learning game be modeled in different phases of the design process?
 - How can software engineering methods be linked with participatory design methods?
 - Which game design principles and methods are suitable for designing of learning games?

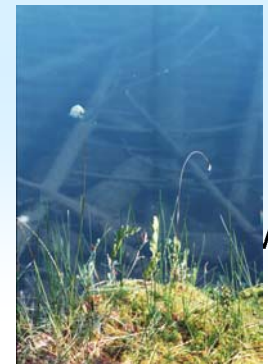
Design Methods for Learning Games



Game Prototypes and Target Groups



1. Talarius – Children’s board game design environment
2. Worldmaker – Learning application for modeling scientific phenomena
3. VISU – Virtuaalisuo (“Virtual Peat Land”) e-learning environment
4. Mobile learning games: Random Equal
5. Mopin game (ProjectFinland)



maker

12-15

Talarius

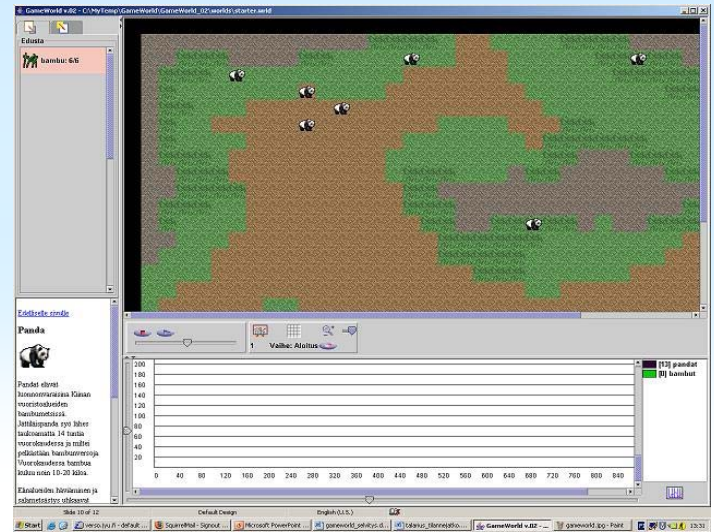


- *Basics*
 - A tool with which children can create their own educational electronic board games and play them on the computer
 - Can be used with different topics and themes
 - Making questions, creating the board, playing the game
 - Two dimensions: 1) Learning by designing and 2) Learning by game playing
- *Partners*
 - Design partnership with a class of 5th-graders (Jyväskylän Normaalikoulu)
 - Research on emotional usability with 3rd-graders (Jyväskylän Normaalikoulu)
 - Research on the effects on learning with 4th-graders (Jyväskylän Normaalikoulu)
 - Starting a collaboration with two kindergartens (Ikuri and Leinola in Tampere)
 - Design partnership with a school class in the upcoming design projects (2005 and 2006)
 - Student project groups at the Faculty of Information Technology

WorldMaker / GameWorld / Gameli

Learning Application for the Modeling of Scientific Phenomena

- Simulation-based learning game for modeling complex scientific phenomena
- Integrating motivational, game-like features into a simulation software
- Based on a simulation software, WorldMaker, developed by professor Nancy Law and her colleagues at CITE (Centre for Information Technology in Education of the University of Hong Kong)



WorldMaker as a learning tool

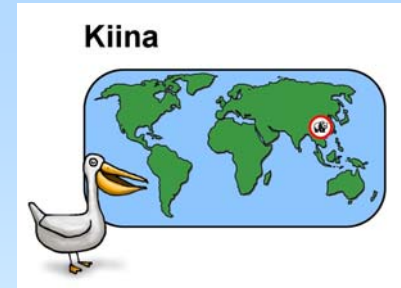
- Field trial with 5th and 6th graders in Finnish comprehensive school (n= 73)
- 2 sessions with each group
- Objectives:
 1. Are pupils able to master the GameWorld?
 2. Are pupils able to understand complex scientific concepts, such as carrying capacity?



Field trial results

- The environment was easy to use and attractive for pupils.
- WM helped number of children to appreciate the idea of food as a limiting resource for determining the population size and further helped some pupils to understand the idea of inter-specific competition and to make predictions about global population changes.
- Visualization helped pupils to conceptualize the population dynamics at systems level.
- However, pupils that did not understand the significance of food as setting up the population size, i.e the carrying capacity, had also difficulties in understanding the population dynamics.
- Anthropocentric thinking, visual representations alone was inadequate for helping pupils to change their reasoning into systems level.

Phases of Further Research and Development



- GameWorld prototype 1: Developing the simulation software WorldMaker into an educational game
 - GameWorld 1.0 pilot version (March 2005), project group Gameli (game-like features, separate editor mode)
 - Evaluating the process and products of the pilot project (spring 2005)
 - *Implementing a new game field (summer 2005)*
 - *Designing a game field from content and pedagogical starting points*
 - *Trials of the new game field (autumn 2005)*



Trials in the Spring 2005

- Class of 6th-graders from Keltinmäki school
 - Design partnership
 - Evaluation of game fields
 - Further development
- 5th- and 6th-graders from Pohjanlampi school
 - Assessment of learning
 - Evaluation of game fields (participatory design)
- 6th-graders from Lohikoski school
 - Evaluation of game fields (participatory design)



Phases of Further Research and Development, cont.

- GameWorld prototype 2: Possibility to create new fields and edit existing game environment
 1. Improving the editing functions and game-like features
 - Creating game fields in schools or by experts of different topic areas
 2. Content development: curriculum, textbooks, teacher and pupil involvement
 3. Pedagogical development
 - Integration with Knowledge Forum (online discussion space and collaborative learning)
 - Development of evaluation tools, online GameWorld?





Virtuaalisuo ("Virtual Peat Land") - e-Learning Environment for the Leivonmäki National Park

- An interactive web-based e-learning environment about peat lands ecosystems
- An open web-based learning environment to be used at Leivonmäki national park, can be accessed from anywhere
- For educational and academic use
 - Users include e.g. teachers and students from educational institutions of different levels, as well as other people who are interested in the topic
 - Can be expanded into a more general application to be used in science education
- Provides a tool for generating and deepening one's knowledge about peatland nature, and assessing one's skills



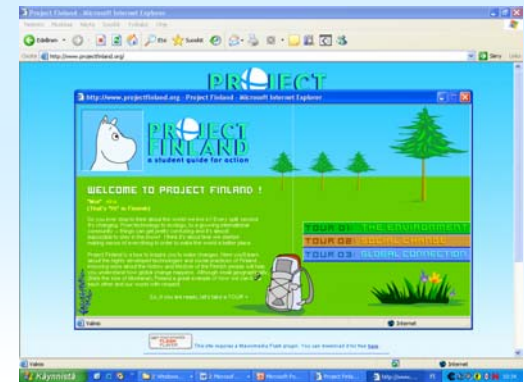
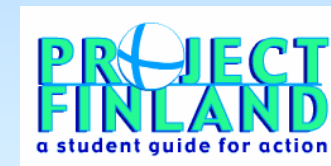
Mobile Learning Games

- Mobile game for studying mathematics
 - Random Equal game as the focus of the study
 - The idea is to form an equation of given numbers and operators within a time limit
 - Developed by 3D Arts
- Usability study of the game, April-May 2005
 - Goal: To identify the most essential usability shortcomings of the game, and to propose recommendations for its further development
 - Points of view: Game usability and pedagogical usability
 - Method: Usability testing (observation) and player interviews after playing
- Preliminary results
 - The starting level of the game has been regarded as rather demanding; it is difficult (especially for younger players) to get a grasp of the game
 - The idea of the game is fresh and interesting; on the other hand it suffers from lack of variation
 - Is well suited for playing on a mobile platform
 - Possible learning advantages: Improving mental arithmetic skills, understanding equations, improving logical thinking



Project Finland

- Interactive web application (www.projectfinland.org) developed by the Embassy of Finland in Washington, D.C.
- Designed for 9 to 12-year-old children in American schools
- An educational game that consists of three interactive tours: The Environment, Social Change, and Global Connection
- Each tour includes a quiz and a “take action” section → Children collect badges and animation clips into a virtual backpack
- The Moomin character created by Tove Jansson accompanies and guides the user on the site



Further Information

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