

Technology integration in mobile-based learning environments



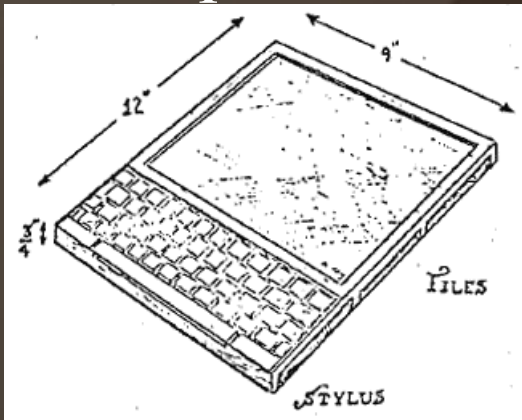
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Agenda

- Background
- Examples of mobile-based learning environments
- Technology integration model
- TI case study 1: LieksaMyst
- (TI case study 2: Heroes of Koskenniska)
- Future aspects and conclusions

Background – Mobile-based learning

- A form of e-learning where the learner uses a mobile device for accessing learning materials and activities across contexts at any time
- Sharing of created content, resources
- Started off with the Dynabook, nowadays the technology is in our pockets



(Wikipedia, Wikimedia)



University of Warwick



Background – Mobile-based learning

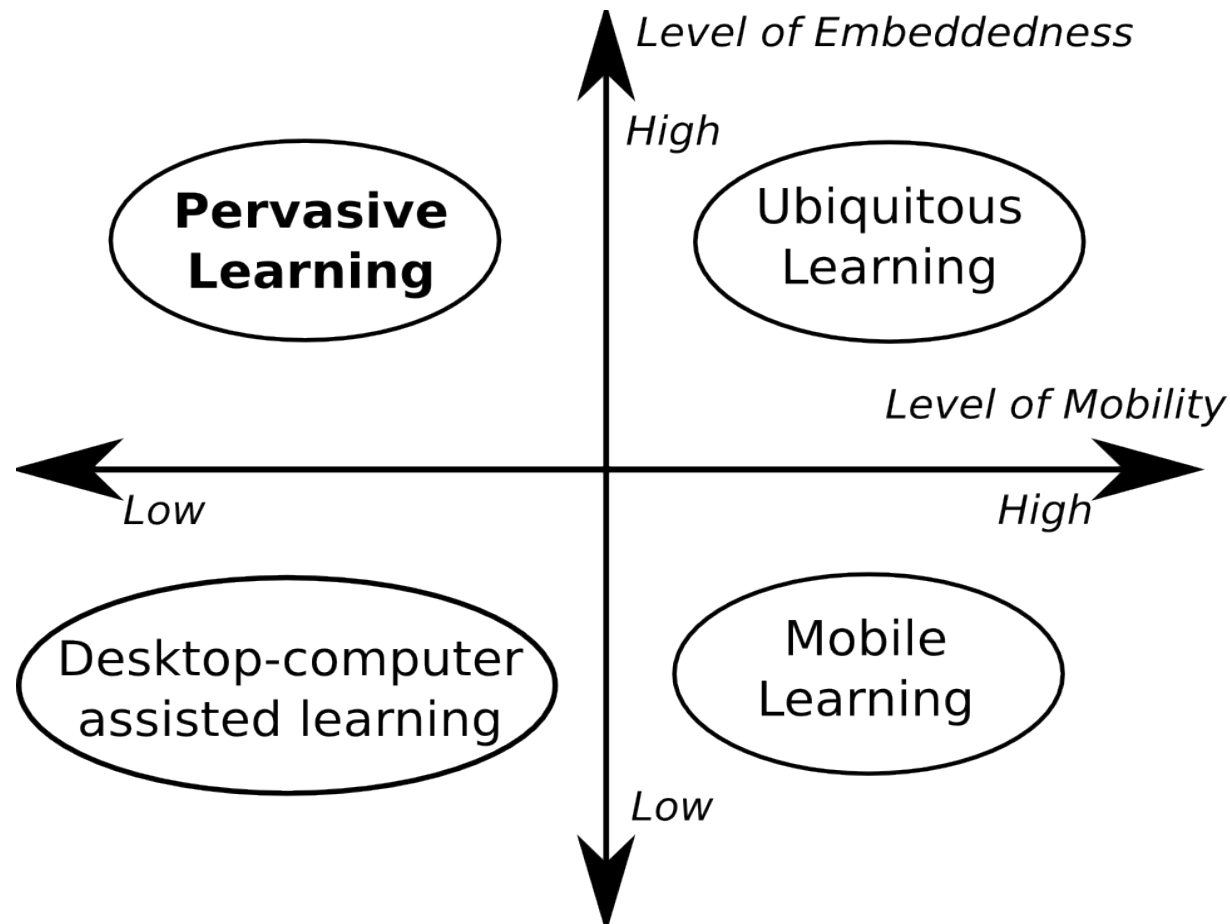


Figure 1. Types of learning (Lyytinen and Yoo, 2002)

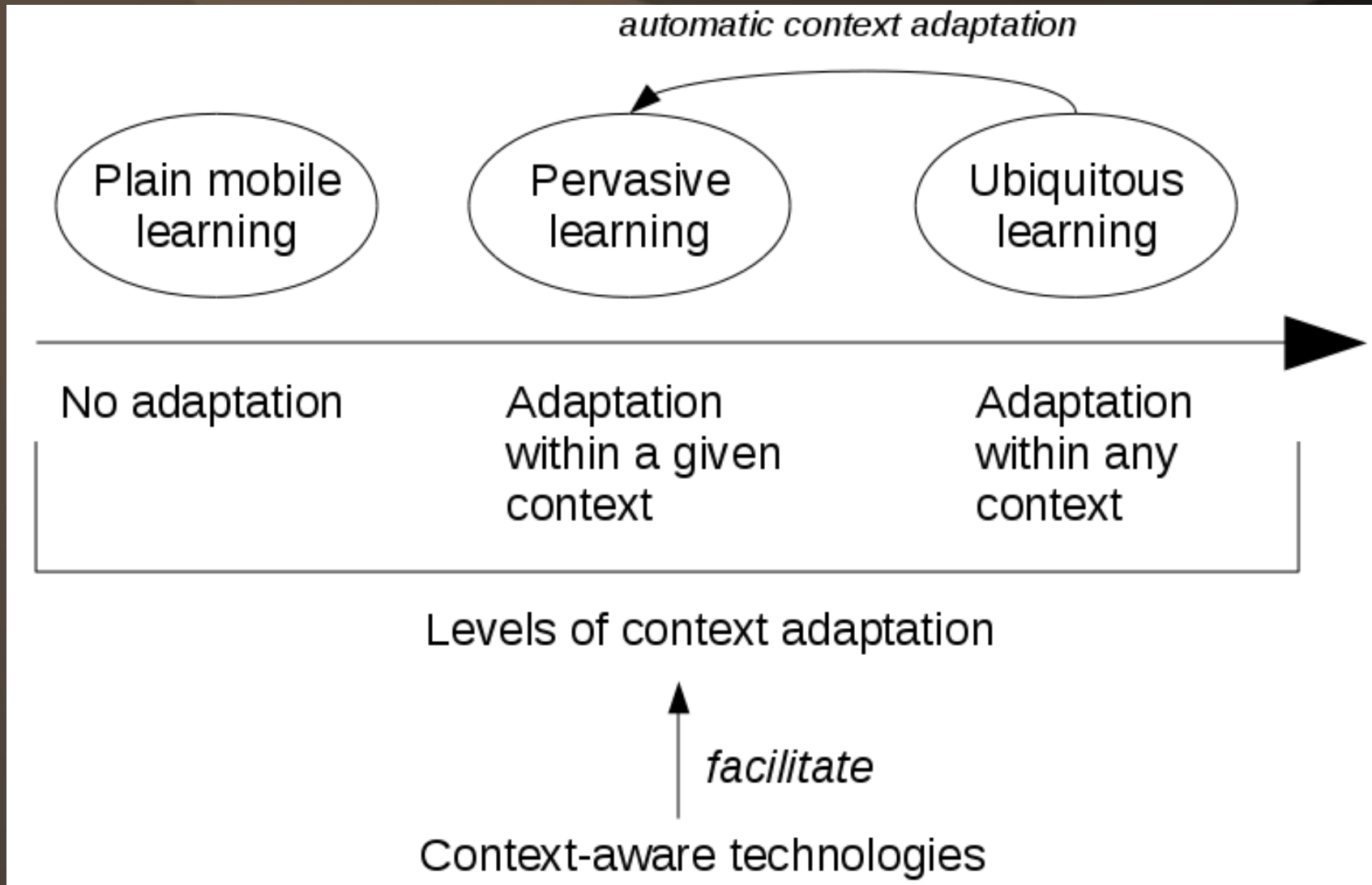
Background – Mobile-based learning

- Example: targeting at museums
 - Pervasive learning space (PLS): a specific museum, tightly connected to the museum's context
 - Ubiquitous learning space (ULS): all museums in the city, automatic delivery of context-sensitive content at each location
 - Mobile learning space (MLS): on-demand content delivery of any museum in the city, no context-awareness
 - Desktop learning space: a web-based access to the museum's website (virtual museum), no context-awareness

Background - Context

- What is context?
 - Where you are, who are you with, what resources are nearby (Pascoe, 1998), when (what time) is it, what are you doing, and how are you feeling?
 - “...is all about the whole situation relevant to an application and its set of users...” (Dey, 2001)
- What is context-awareness?
 - Not just location-awareness
 - A system is context-aware if it uses a context to provide relevant information to the user, where relevance depends on the user's task (Dey, 2001)

Background – Context Adaptation



Context Adaptation (2)

- Adaptation to diverse aspects of context: physical, cultural, political, technological, social, pedagogical, personal ...)
 - Context-aware technologies that facilitate context adaptation may be:
 - Various sensors (e.g. environmental, body)
 - Smart tags
 - Positioning technologies
- The use of these technologies depends on the required level of context-awareness

Background – Pervasive Learning Space (PLS)

- A learning environment where...
 - ...learning is situated in an authentic context
 - ...learning process is adapted according to the backgrounds of the learners
 - ...the learner can become totally immersed in the learning process (i.e. enter the *flow*)
 - ...physical environment provides resources (e.g. objects) for learning
 - ...small (unobtrusive) embedded devices communicate together to achieve context-awareness
 - ...the virtual world may extend the real world (i.e. augmented reality)

Some examples

- SciMyst (2007-2009)
 - TekMyst (2008)
 - LieksaMyst (2008-)
 - UFractions (2009-)
 - Heroes of Koskenniska (2009-)
- + Ubiquitous Healthcare system (2008)

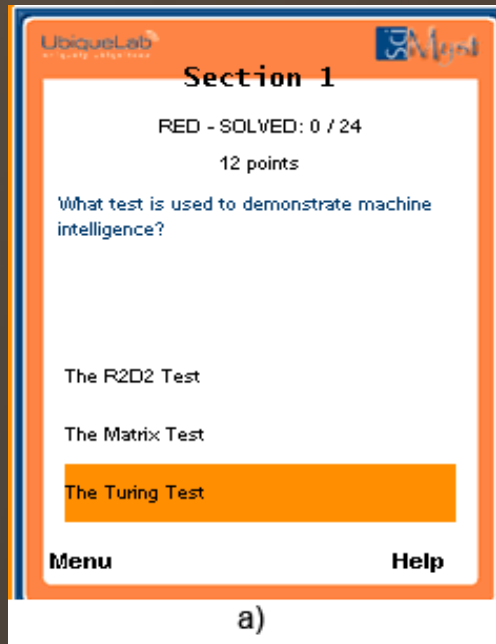
Examples: SciMyst (2007-2009)

- Multilingual adventure game for the annual SciFest science festival in Joensuu
- Idea: engage and motivate visitors of the festival to explore the environment in a novel way.
- Players use their mobile devices to adventure through a real world game environment and solve quiz-like challenges related to the surrounding exhibitions and workshops.
- Recording impressions
- Website integration

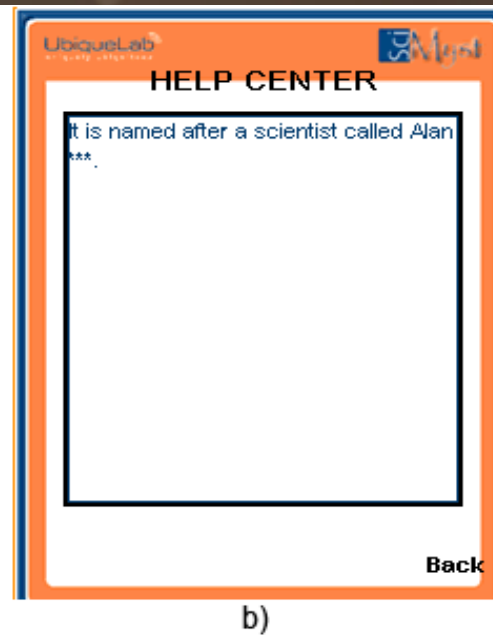


Examples: SciMyst (2007-2009) (2)

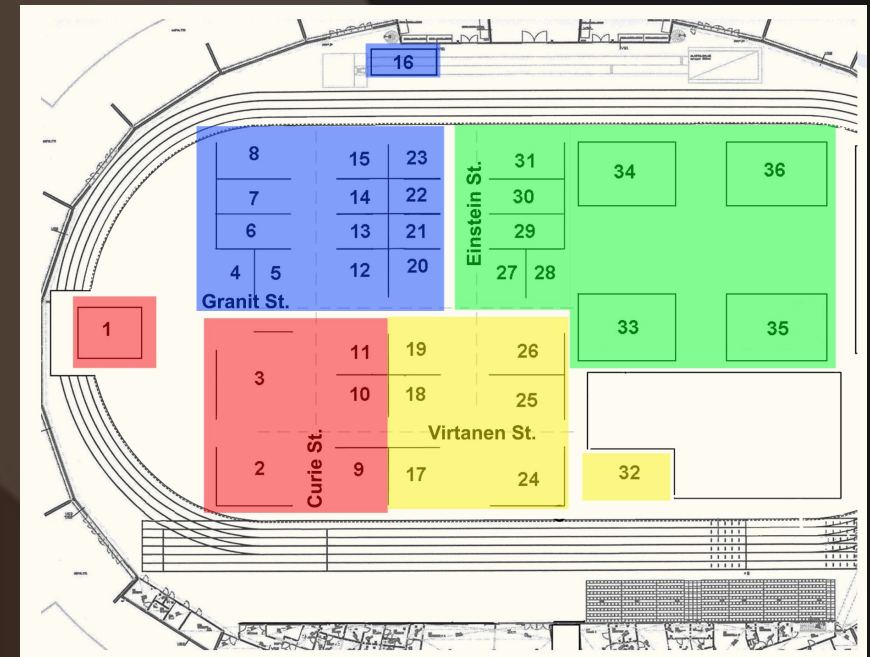
- Help feature has been implemented in multiplayer mode
 - Interaction among players and NPCs
- Game area is divided into sectors by colours
- Player positioning and object recognition with 2D bar codes



a)



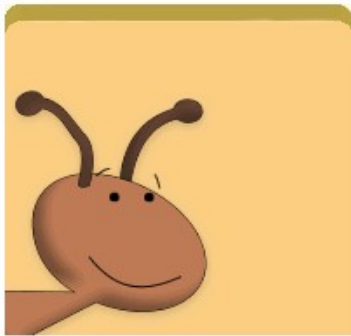
b)



Examples: TekMyst (2008)

- Customised version of SciMyst for the Museum of Technology in Helsinki.
- Idea: an alternative way to gain knowledge at the museum (and help the ants).
- Story about hard-working ants and sharing knowledge.
- Some changed game rules, added levels, mobile-based questionnaire
- A website





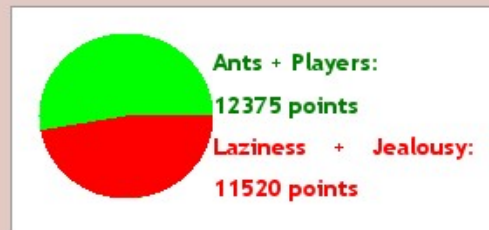
TekMyst

[home](#) [game](#) [story](#) [vs](#) [scores](#) [gallery](#) [ui](#) [credits](#) [+](#)

Visitors vs Ignorance

Here you can find the current status of the battle against ignorance, as well as the development of the battle during the TekMyst gameplay at the Museum of Technology in Helsinki. The red color marks the ignorance points, and the green colour marks the visitors' knowledge points. Ignorance is growing every hour by 320 points and knowledge grows as players gain knowledge.

By solving enigmas of the TekMyst, helping other players, or recording impressions, you can make sure the green colour will beat the red colour. The figures below are updated in real-time when the game is active, so when a player solves an enigma, the result is shown immediately on this page. Last ten contributions are also shown at the end of the page.



Ants: L+ J:	
Sun 31, klo 15 - 16:	639 320

News

- CONGRATULATIONS!!!!

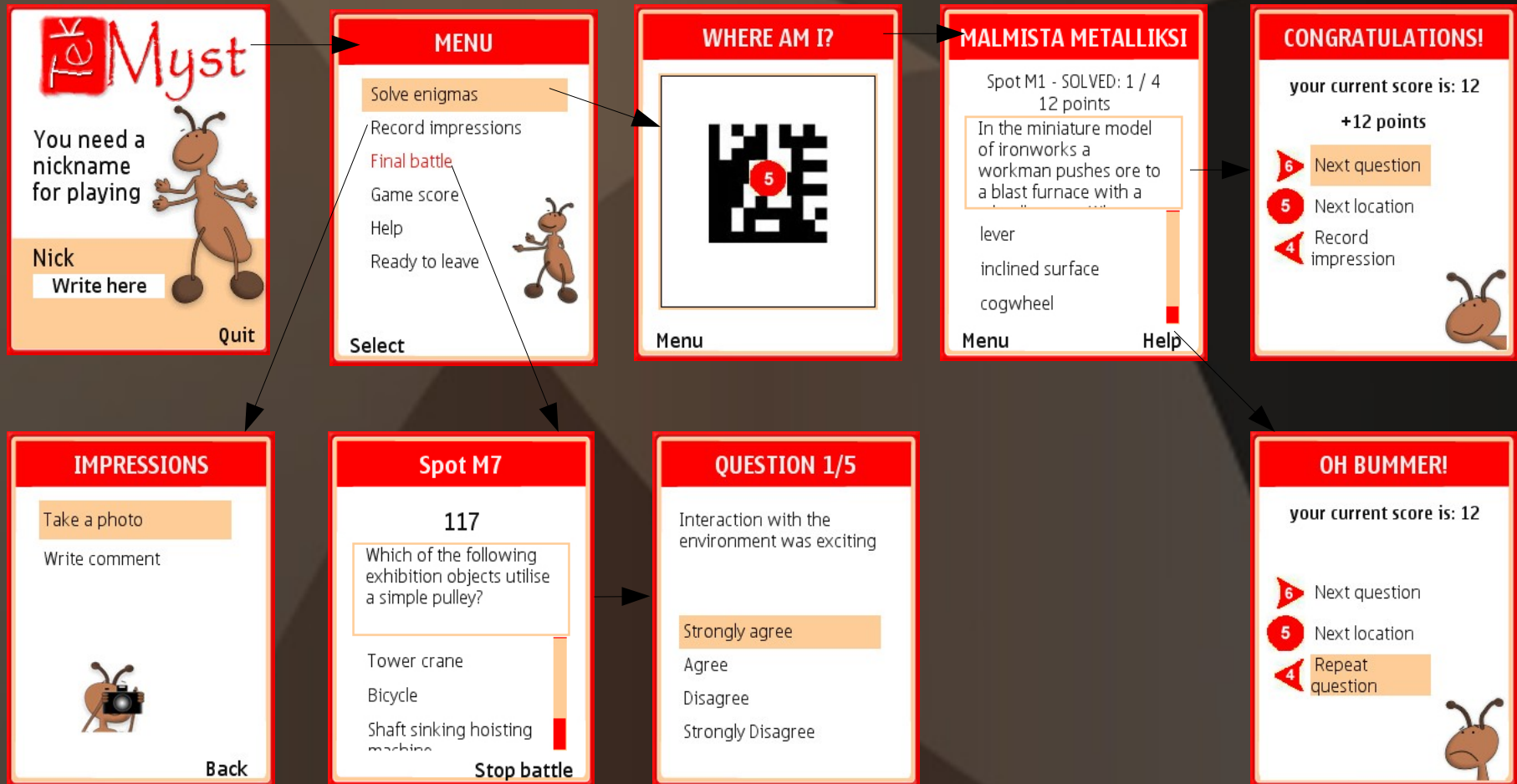
Players and Ants won by 855 points.



As a result the ants will survive next winter, thanks to all the players!

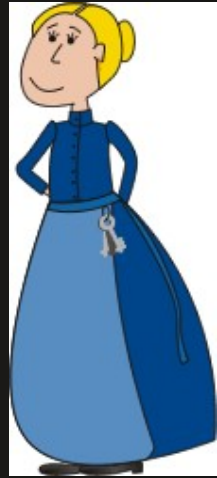
- Public test - August 26-31th.
- Test prototype - July 17th.
- Content delivery June 20th.

Examples: TekMyst (2008) (3)



Examples: *LieksaMyst* (2008-)

- In an open-air living museum in Lieksa, Finland
- Idea: A story-telling approach to immerse learner in a "time travel" experience. Various characters and stories are tightly connected to the authentic context and surrounding objects
- Other features: database discovery tool, RFID-based indoor exhibition browser, content editor.



Introduction

Jussi

... you should let me know first which part of the day you will be joining me...

aghrrr....



Pause Continue Back

a)

Choice

Phone

Please select what would you like to do next:

Morning

Afternoon

Whole day

Pause

b)

6:00 - Wake Up

Phone

Winter day 1930 at Pusurinjoki.
Jussi's day starts 6:00 am



Continue

c)

8:00 - Getting Ready

Jussi

As there is no space in this camp just for observers, you should do something productive and help me to reach my things.



Pause Continue

d)

8:00 - Getting Ready

Jussi

For my feet I need the foot wrapping. Reach them for me, it looks like this one:



Continue

e)

8:00 - Getting Ready

Phone

Please give your answer below

Jalkarätti, foot wrapping



Back

f)

8:00 - Getting Ready

Jussi

What? Don't you like the smell?

Hmmmm... It is more important to cover my feet.



Continue

g)

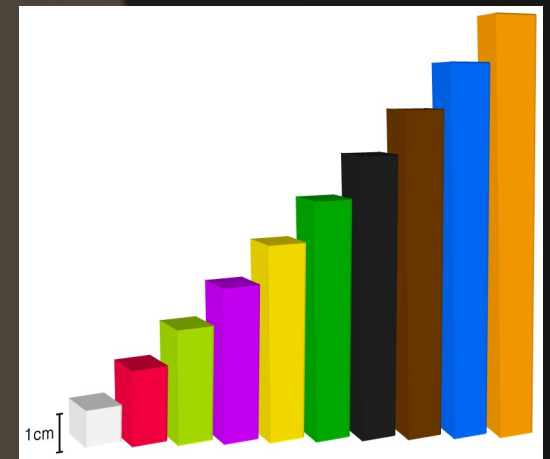
a-b: Jussi lets player to choose which level (time period) to play.

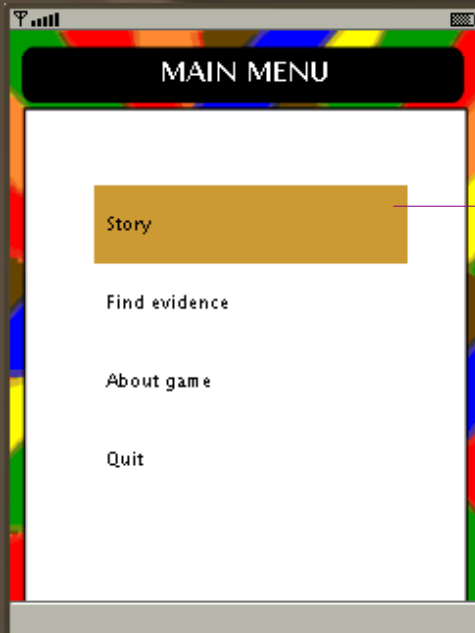
c-d: Story combines text, images and audio. Jussi's character is taciturn and even slightly impolite.

e-g: In addition to multiple choice questions, Jussi asks the player to locate objects and input code.

Examples: UFractions (2009-)

- A contextualised, story-based math game for South African context, later evaluated also in Finland.
- Idea: learn fractions with mobile device and fraction sticks. A compelling story about leopards was developed to keep the players motivated.
- Differences to LieksaMyst: points, context-sensitive help, diplomas, many actors in one story



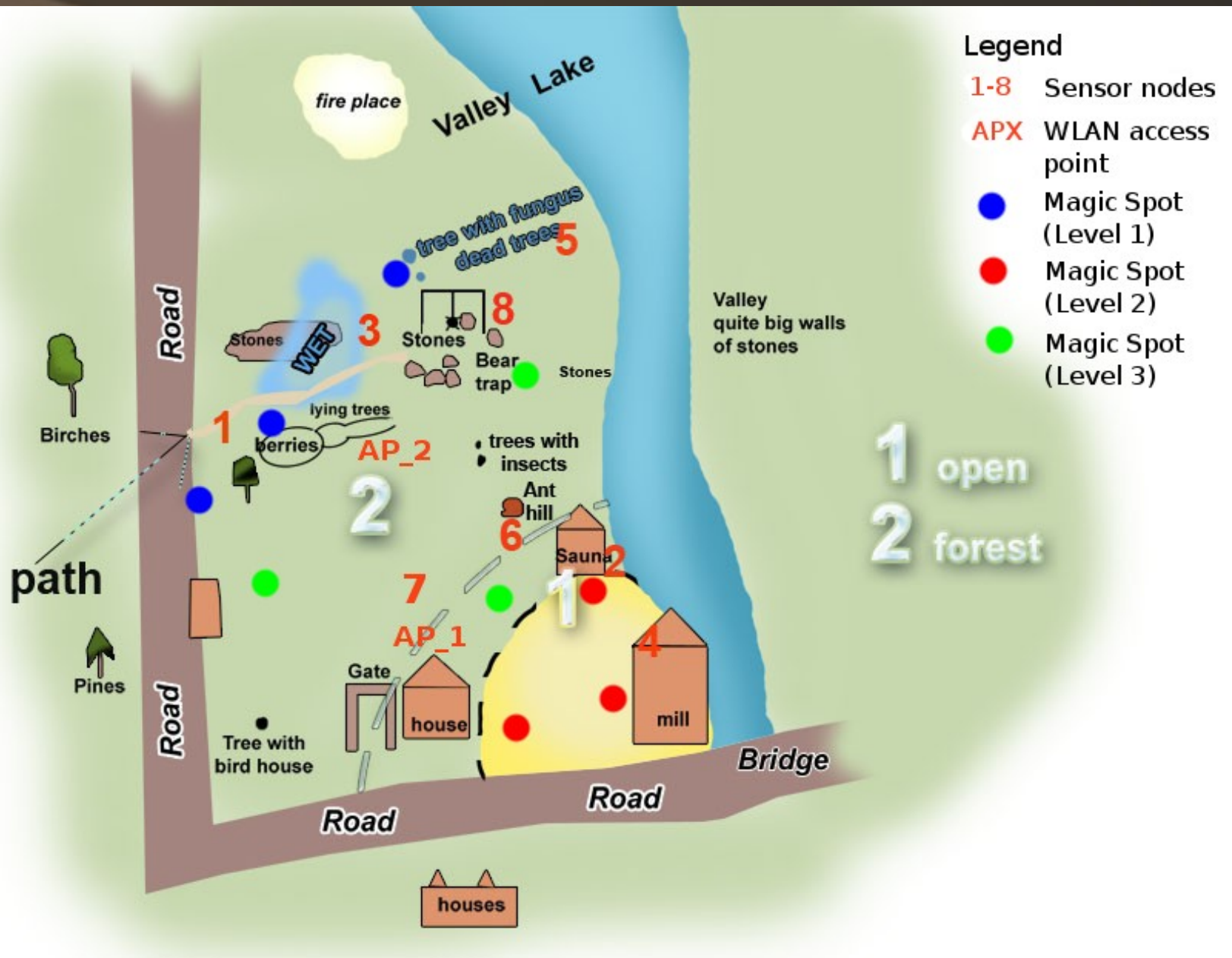


Examples:

Heroes of Koskenniska (2009-)

- At the Koskenniska Mill and Inn Museum area at the UNESCO Biosphere Reserve in North Karelia, Finland
- Idea: increase environmental and cultural awareness
- Wireless sensors: temperature, humidity, illumination, infra red
- Story-based structure to immerse the learners, characters from Kalevala, the Finnish national epic
- Content based on trees, plants, animals of the forest and cultural history of the area
- Complementary information boards






Examples: Heroes of Koskenniska (2009-) (3)

Ukko WP: 0 HP: 100 A: 1

Start by communicating with the Forest. Listen and learn from it.



Remember: your goal now is to earn knowledge and keep yourself alive.

menu continue back

However, not all the trees live that long. Can you think and tell me which of the following can be the reason of a tree death?


fungi

wind

snow

menu send

Now look carefully the building of the mill. Using your previous forest knowledge you should be able to tell me which type of wood is it made of?



zoom select back



From which tree is made this medicine?




zoom select back

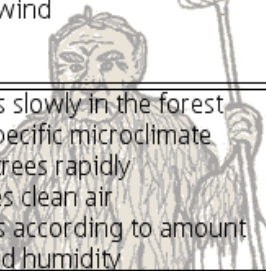
Now that you are more sensible to this detail, tell me which landscape is more in harmony with the nature?



zoom select back

Last fight

1. Humidity
2. Microclimate conditions
3. Every ecosystem
4. Strong wind
5. Usnea



- a. changes slowly in the forest
- b. has a specific microclimate
- c. can kill trees rapidly
- d. indicates clean air
- e. changes according to amount of light and humidity

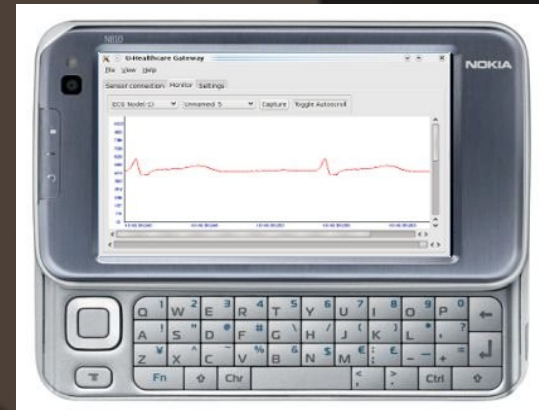
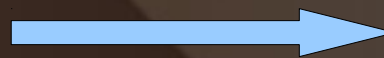
WP: 377 HP: 170 A: 2

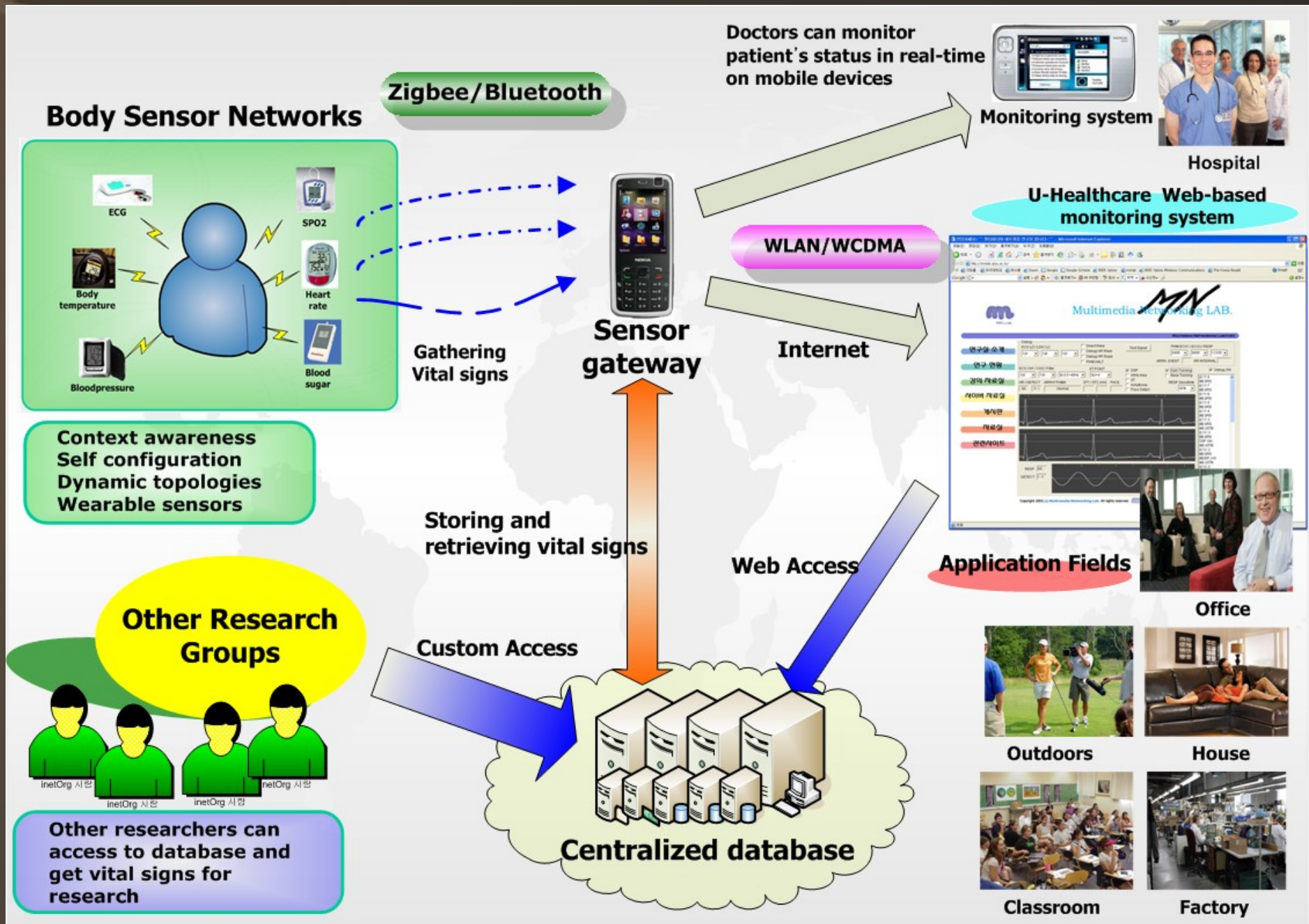
menu write send



Examples: U-Healthcare System (2008)

- Collaboration with MNLab at Ajou University, Korea
- Idea: enable anywhere-anytime health monitoring by wireless sensors and a mobile device
- Mobile gateway (N810) supports also other types of sensors
 - Tested with ECG, environmental sensor nodes (HoK)



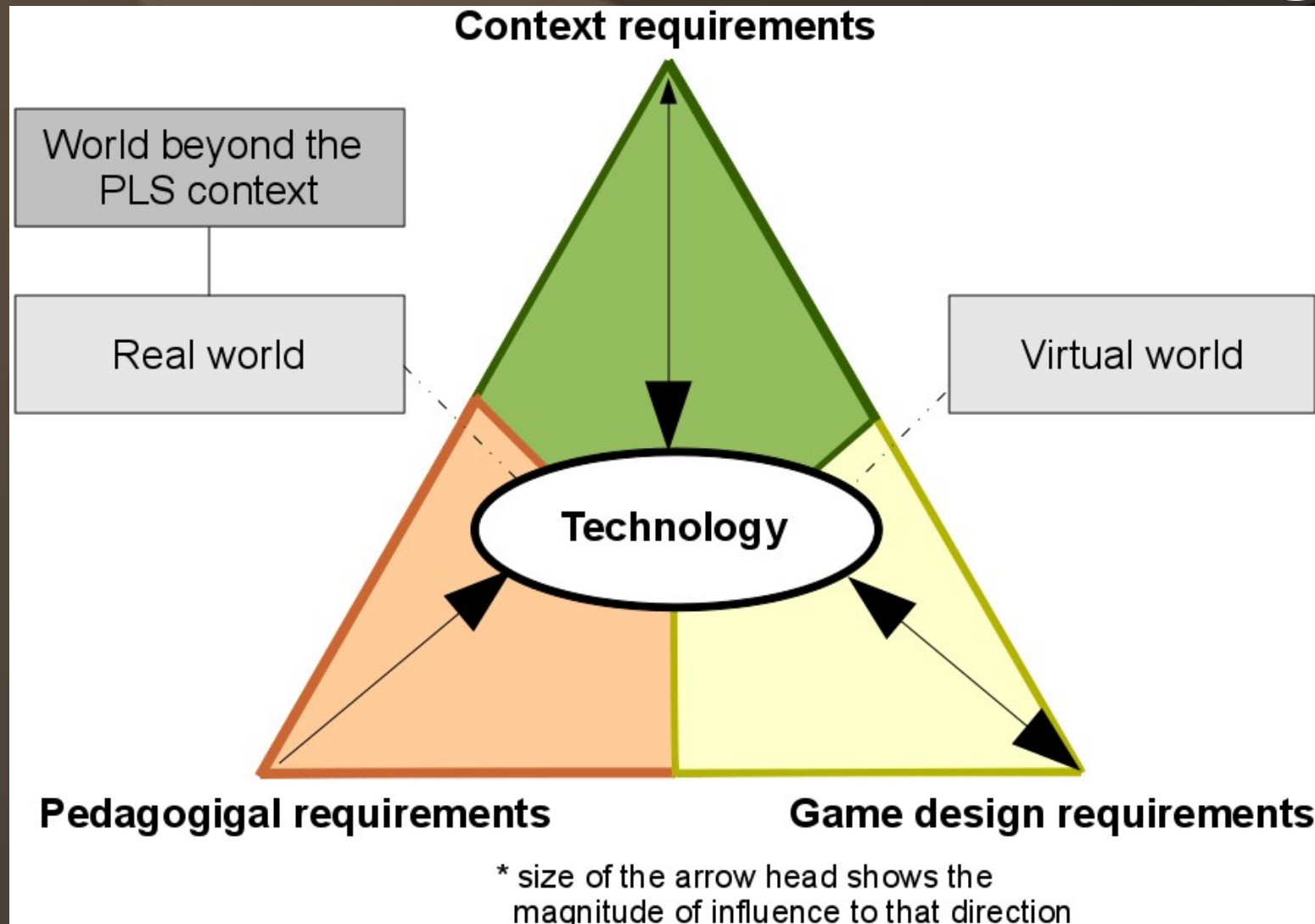


Technology Integration

- Origins: how to integrate technologies to support teaching/learning activities in a classroom?
- Our approach: how can we help the designers of pervasive learning spaces to choose and integrate the appropriate technologies?



Technology Integration Model for Game-based Pervasive Learning



TI Model – Pedagogical Requirements

Support and assessment	Authenticity and relevance
Scaffolding techniques	Authentic context
Support for just-in-time reflection	Authentic activities that relate to the real world
Support for post-reflection	Compelling narrative to facilitate immersion
Immediate feedback	Gained experiences integrated and applied across different subject areas
Integrated, authentic assessment (if applicable)	Personal relevance
Interaction and collaboration	Unobtrusive technology
Social negotiation and collaboration	User profile and perspectives
Multimodal exploration of the environment	Multiple roles, perspectives, skill levels
Ownership	Consideration of background, prior knowledge and experiences
Ownership of the learning process and outcome	Consideration of learning styles
Ownership of the technology	

TI Model – Design Requirements

- **Context-awareness** (level of context-awareness required)
- Game dynamics (e.g. use of technology to support the flow of learning experience, considered case by case)
- Interaction (e.g. using technology to establish interactions among learners, the system and objects)
- Content (e.g. types of media used (digital and non-digital), connection of the real world objects to the digital content)

TI Model – Context requirements

- **Resources** – financial and human (e.g. size of budget, availability of required technical skills)
- Cultural (e.g. prohibition of flash photography, museum curator's attitude to technology)
- Technical (e.g. availability of network/electricity)
- Environmental (e.g. weather constraints on technology use, desirability of silence in the environment)
- Social (e.g. contextual support for collaborative learning)
- Temporal (e.g. limitation on usage time of the PLS, time available for implementation)

System Architecture in TI

- Some challenges for system architecture
 - each context is different
 - each environment has different requirements
 - users are mobile
 - users are impatient
 - there are many different handsets out there
 - users want different things presented in different ways
 - content should be modifiable by a non-programmer

System Architecture in TI (2)

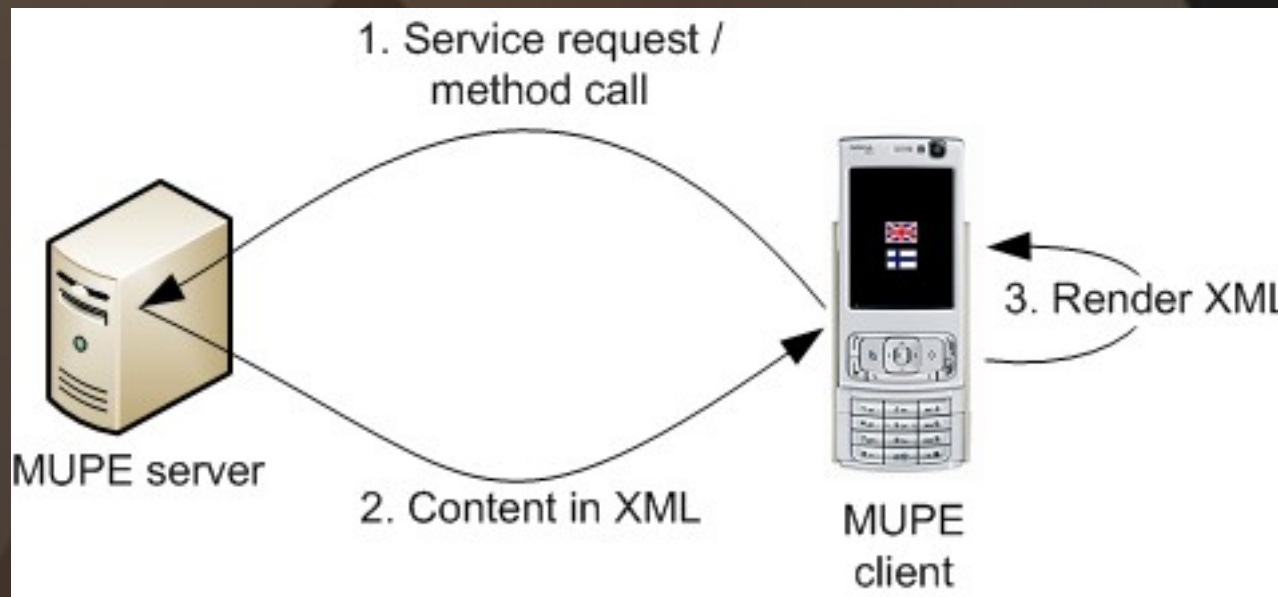
- A good system architecture for pervasive/ubiquitous learning should:
 - interconnect various technologies to form a seamlessly working system
 - be reusable
 - rely on open standards, interfaces and platforms
- Important attributes are *viability* and *portability*:

Viability is the extent to which a given system can be adapted to the requirements of new stakeholders or subject matter.

Portability is the extent to which a given system can be transferred to a new physical context without adjusting the technical implementation.

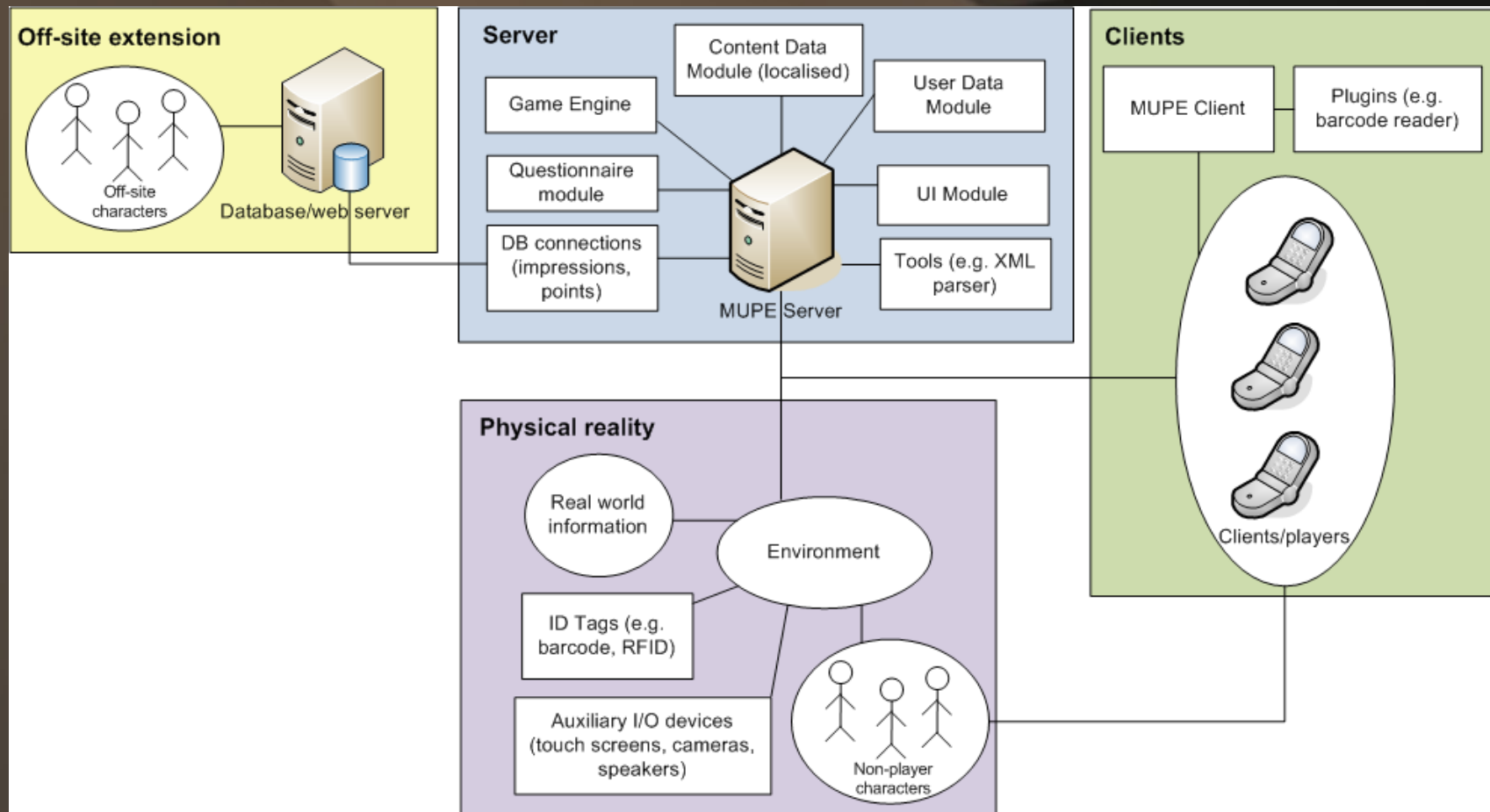
Example Architectures

- Two architectures: Myst and HoK, both built on top of MUPE (Multi-User Publishing Environment)
 - Java-based open source client-server platform
 - Content delivered by XML
 - Plugin API: GPS, 2D bar codes, NFC/RFID

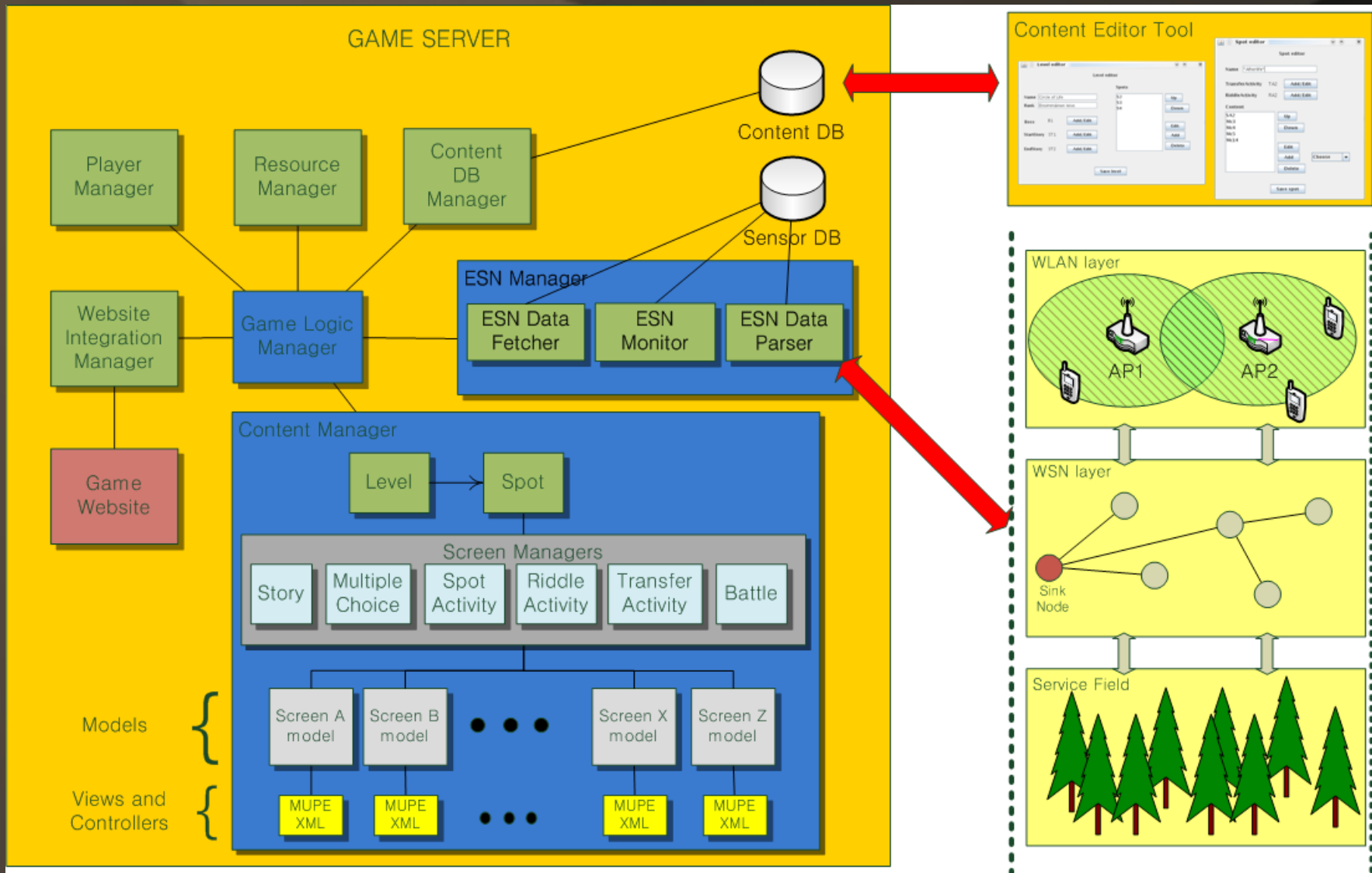


Example Architectures – Myst

- All games except Heroes of Koskenniska



Example Architecture: HoK



Evaluating Technology Integration

- **Usability** – good usability indicates successful TI
- **User perceptions on technology** – unobtrusive technology does not disturb the user (complements usability evaluation)
- **Stakeholders' perceptions on the success of technology integration** – stakeholders (e.g. museum curators) can confirm the success of TI from the perspective of context
- **General pedagogical effectiveness** – by supporting pedagogical requirements, technology facilitates the pedagogical effectiveness of the tool

Case Study – LieksaMyst meeting pedagogical requirements

- *Consideration of learning styles* – Different learning styles were considered by supporting of various media types and multiple application types within the PLS.
- *Social negotiation and collaboration* – The system is based on a client-server approach and the server is constantly aware of the status of each client. Therefore the infrastructure to allow player-to-player communication is available, but is not currently used in any of the LieksaMyst's applications.
- *Multimodal exploration* – By using mobile technology and location-awareness it was possible to embed context-sensitive sound effects and authentic photographs in the learning experience.

Case Study – LieksaMyst

meeting pedagogical requirements (2)

- *Ownership of the technology* – The client runs on a J2ME device with appropriate computing and memory resources, hence potentially supporting a large number of visitors using their own mobile devices. In practice, as the museum borrows Nokia N95 phones to visitors, this requirement is not fully met.
- *Authentic context* – Technology integration respects the authentic context while attempting to increase the feeling of authenticity through various on-screen effects that could be related to the physical objects. Additionally, context-awareness support through numeric tags connects the game content to the authentic context.

Case Study – LieksaMyst meeting pedagogical requirements (3)

- *Unobtrusive technology* – The only technology that the learner can physically see, touch or hear while using LieksaMyst is the mobile phone. We chose to use the Nokia N95 as it is reliable and powerful enough for running the client software. In-game media content was rendered to be as light as possible while maintaining an acceptable quality. As network problems during the learning process may negatively affect the learning experience, we placed the server in the museum's premises and connected it to a WLAN network to maximise reliability of the network connection.

Case Study – LieksaMyst

meeting context requirements

- *Resources* – Financial resources allowed the museum to acquire a server, phones, and a WLAN. Construction of WLAN was the most costly operation as many of the old buildings did not have electricity outlets. Human resources from the museum were excellent in terms of content matter expertise, but technical development and server maintenance were left to researchers. For this reason, the system was implemented with technologies that were considered stable and which supported remote maintenance.
- *Cultural* – The cultural context of the museum was characterised by the desire to maintain authenticity. Visible stationary technologies such as touch screens or tags, were not allowed. Additionally, touching objects or photographing with flash was strictly forbidden.

Case Study – LieksaMyst

meeting context requirements (2)

- *Technical* – Many of the old buildings did not have electricity or heating. The museum also did not have necessary server hardware or phones, but these were later acquired. The museum is within the coverage of a 3G network, but WLAN was built to minimise usage costs.
- *Environmental* – Lack of artificial light and heating renders the buildings dark and cool especially at the beginning and at the end of the season (May-September). To conform to these environmental requirements, mobile devices were used as the primary interaction tools.

Case Study – LieksaMyst

meeting context requirements (3)

- *Social* – Museums in general are places that support social encounters and collaborative learning. We chose mobile devices as a technology that allows playing in groups. Additionally, the client-server approach was considered to be useful for player-to-player interaction. LieksaMyst does not yet have collaborative features, but the technology is available to support it.
- *Temporal* – Outdoor exhibitions in Pielinen museum are open from May to September. Long winter breaks have been used to integrate technologies into the design process, to create stories, to develop and test additional features, and to analyse gathered data.

Case Study – LieksaMyst meeting design requirements

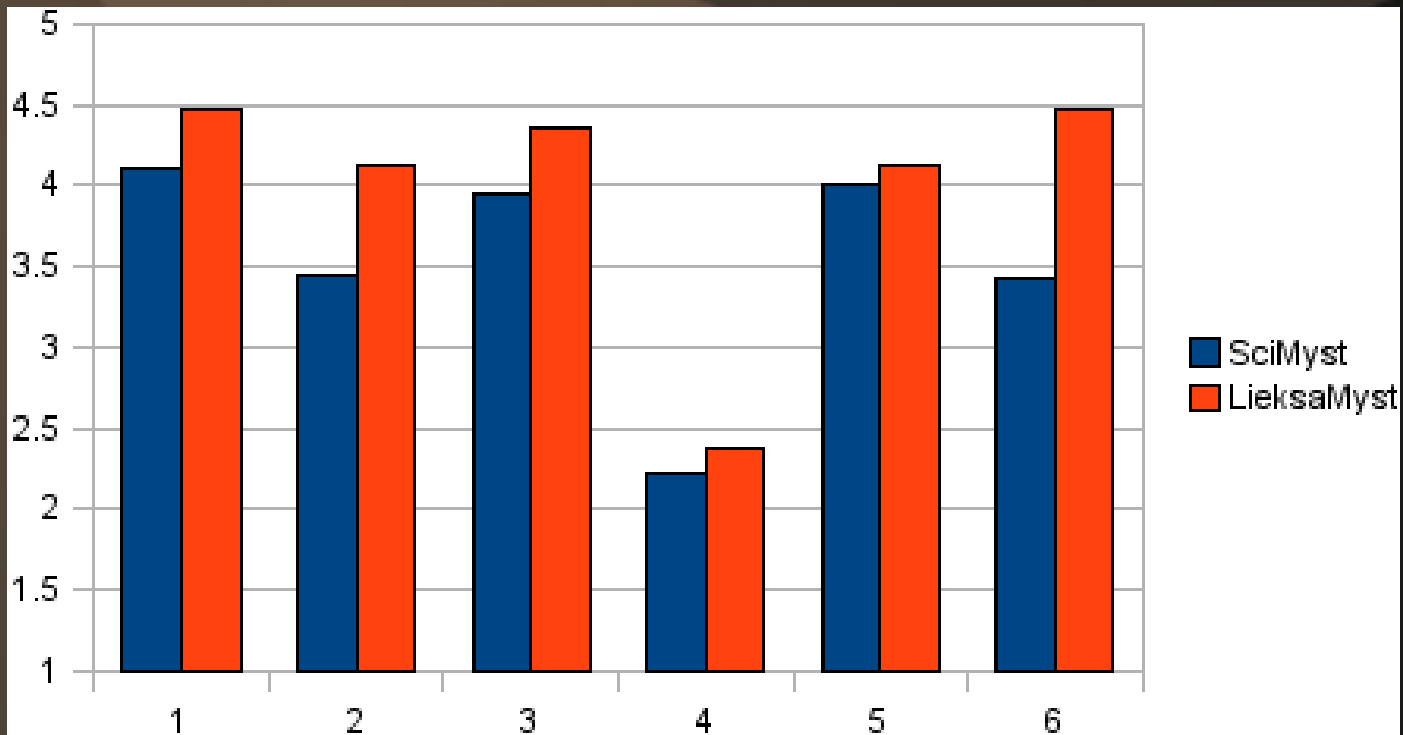
- *Context-awareness* – The design requested location-awareness within any of the buildings. Available resources and the museum's culture restricted the use of advanced technology. A system combining authentic-looking wooden tags with manual code input on the mobile phone was implemented. The server was also made aware of the current time and other players present in the same room.
- *Game dynamics* – Physical objects were used as part of the game to create connections between the objects. The design process requested the use of rich multimedia to support player immersion, hence the system was built to support flexible use of text, images and sound.

Case Study – LieksaMyst meeting design requirements (2)

- *Interaction* – WLAN connection was used for client-to-client as well as client-to-server interactions. The game design process promoted the interaction between a player and virtual characters by dialogues on a mobile device, and connected the story to the real world objects through wooden tags with codes.
- *Content* – The design process required that the game content should be created in such a format that new content could easily be added later. The game server was designed to support the easy addition of new content in the given XML format, including various media types (text, images and sound). Later a graphical editor was constructed to fulfill the requirement for easy content management. Another requirement was to support multiple languages, and currently LieksaMyst has Finnish and English content ready.

Case Study – LieksaMyst

Usability evaluation



- 1: Language was easy to understand
- 2: Using the phone for playing was intuitive
- 3: It was fun to play with the phone
- 4: The screen was too busy
- 5: The size of the text was big enough
- 6: It was easy to use the phone as a tool for playing

Case Study – Heroes of Koskenniska meeting pedagogical requirements

- *Consideration of learning styles* – Different learning styles were considered by supporting of various media types. Information boards were also available.
- *Social negotiation and collaboration* – Client-server approach enabled client interconnectivity. The players were also encouraged to play in groups of 2-3 (e.g. a family). Game itself does not have built-in multiplayer features.
- *Multimodal exploration* – By using mobile technology, location-awareness and environmental awareness, it was possible to embed context-sensitive materials and environmental data in the learning experience.

Case Study – Heroes of Koskenniska meeting pedagogical requirements (2)

- *Ownership of the technology* – Similar to LieksaMyst, N95 phones are available for borrowing. Additionally, it is possible to download the application for devices that meet the requirements.
- *Ownership of the learning process* – the players can record pictures and comments during the journey. Recordings are stored for later reference.
- *Authentic context* – Technology integration respects the authentic context while attempting to increase the feeling of authenticity. Context-awareness support through riddles connects the game content to the authentic context, and environmental data tells the player more than the eye can meet.

Case Study – Heroes of Koskenniska meeting pedagogical requirements (3)

- *Immediate feedback* – in addition to in-story feedback, the player can access real-time sensor data at any time.
- *Unobtrusive technology* – The only technology that the learner can physically see, touch or hear is the mobile phone. Wireless devices are visible but they are either high in the trees or placed in wooden containers on the ground. WLAN signal is enhanced with powerful antennas so as to ensure connectivity in the entire game area. Server and WLAN routers are connected to electricity outlets, but some disconnections may occur due to a thunderstorm, for example.

Case Study – Heroes of Koskenniska

meeting context requirements

- *Resources* – Financial resources allowed the us acquire a server, phones, WLAN and wireless sensors, but development work was not financially supported. Students were recruited to assist in the process. System maintenance was left to researchers.
- *Cultural* – Natural environment was kept as authentic as possible. Sensors close to the ground were disguised inside wooden containers. Wooden information boards were painted with natural colours. Loud sound effects were not used to retain the natural silence.

Case Study – Heroes of Koskenniska meeting context requirements (2)

- *Technical* – 2G network was available but WLAN was deemed more cost-effective and fast. Electricity was available in the museum buildings but it had to be extended to the forest for WLAN; sensors use batteries. Hardware and software were not available but these were later acquired. Occasional power failures remains a challenge.
- *Environmental* – Due to Finnish weather conditions, the game is operable from May to September. Hardware is protected with plastic cases and ground-mounted components are protected against vandalism (either by animal or human). Variation of temperature between days and nights was challenging for the batteries.

Case Study – Heroes of Koskenniska meeting context requirements (3)

- *Social* – Koskenniska area is a place for relaxing social encounters. Particularly many families and hikers spend time there. The inn and mill museum was established as an informal learning environment even before the game. Mobile-based approach was used to move the visitors from the museum towards the nature.
- *Temporal* – Area is accessible throughout the year but heavy snowfall makes the forest hard to navigate without snowshoes or skis. Museum is open whole July and otherwise by request. For the game the season is only from May to September due to weather conditions.

Case Study – Heroes of Koskenniska meeting design requirements

- *Context-awareness* – User's location and environmental data was used to provide context-sensitive learning materials that had relevance to a specific spot and to weather conditions in that spot. Player location was detected through riddles.
- *Game dynamics* – Elements of nature (e.g. trees, berries) were used as part of the game. The design process requested the use of rich multimedia to support player immersion, hence the system was built to support flexible use of text, images and sound. More different types of challenges were presented in comparison to LieksaMyst, for example.

Case Study – Heroes of Koskenniska meeting design requirements

- *Interaction* – WLAN connection was used for client-to-client as well as client-to-server interactions, ZigBee was used by the sensors. The game design process promoted the interaction between a player and virtual characters by dialogues on a mobile device, and connected the story to the real world through references to objects and environment's status.
- *Content* – Design process required many different forms of screens and easy content creation. These were met by a screen-based architecture and a content editor. The content editor has some room for improvements in terms of usability (work in progress). All game content is stored in a database with multilingual support.

Future efforts

- Solidify the technology integration model, establish TI methods, evaluate PLSs
- Current application developments
 - TekMyst 2
 - Historical game-based pervasive learning space on slavery in Bagamoyo, Tanzania
 - LieksaMyst: more stories, improving the editor
 - UFractions with smart blocks
 - Combining body monitoring to existing games (e.g. HoK)

Conclusions

- In pervasive (and ubiquitous) learning, the role of context is particularly important
- Successful integration of technologies is a pre-requisite for pedagogical effectiveness of a PLS
- Our TI model considers various requirements that integrated technology should meet
- Actual TI methods and evaluation details remain to be defined
- In the future we can expect PLSs/ULSs to become more adaptive and versatile

Thank you!

DOCTOR FUN

16 Jan 2006



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