CYPRUS UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF MUTLIMEDIA & GRAPHIC ARTS

Multimodal Spaces and Interactive Technologies for Collaborative Learning

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Outline

Researching the supportive and mediating role of technology in promoting collaborative learning

- Study 1: Problem-Based Learning in multimodal information spaces
- Study 2: Interactive tabletops and decision making in the context of pursuing peace

BILATERAL PROJECT
CYPRUS - SLOVENIA

Creative Multimodal Information Spaces for Problem-Based Learning

infospaces.cyprusinteractionlab.com

General aim of the project…

Creative use of technology for the construction of learning spaces and classrooms that can support PBL…

- support communication, interaction, collaboration
- allow information sharing
- motivate physical interaction around the construction of group artifacts
- encourage student reflection

Augmenting a PBL classroom with available technologies…

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- Learners' experiences
- Technology adoption and use
- Support of processes
  - recognition
  - researching
  - reporting
  - reflection

  (by Koschmann & Stahl, 1998)

Different modes of interaction and presentation of information

The multimodal information space

1. Shared surface with projection

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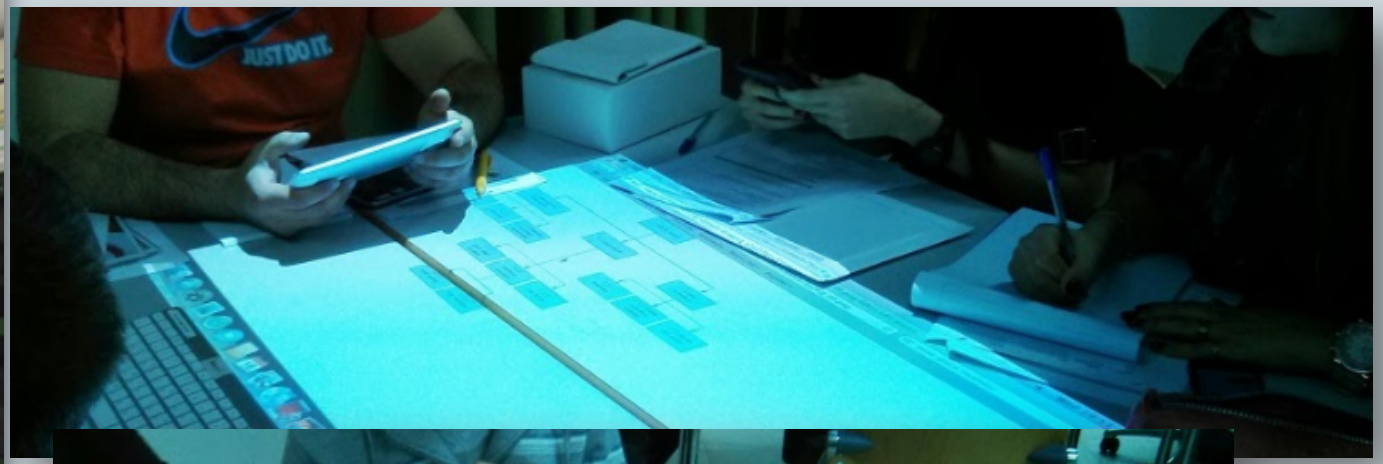
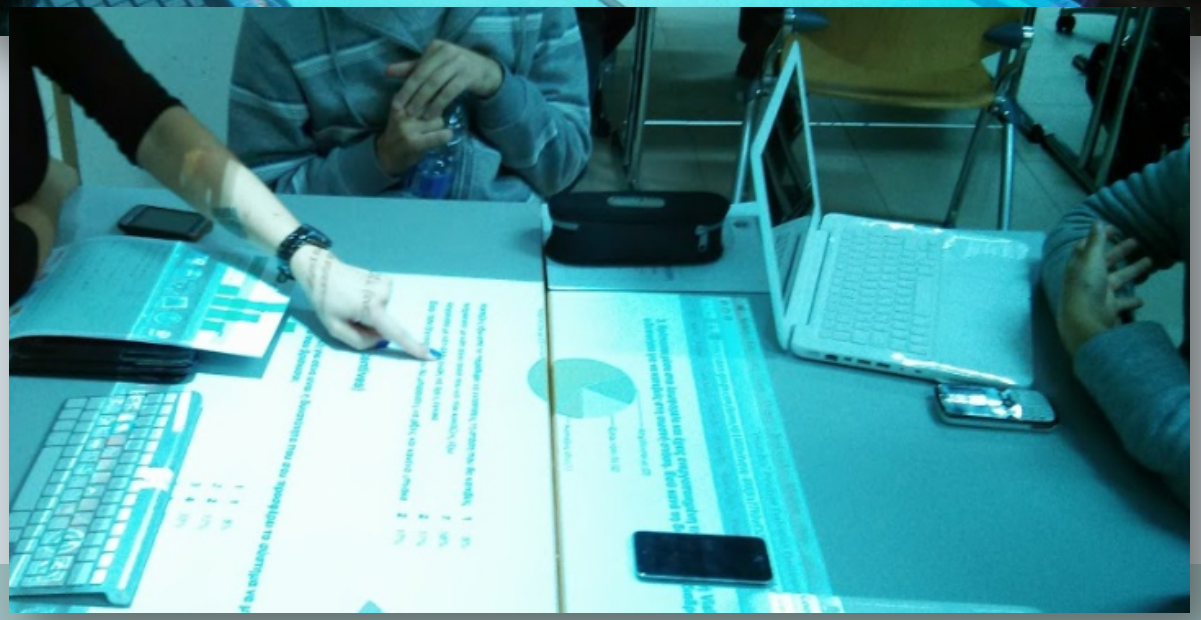
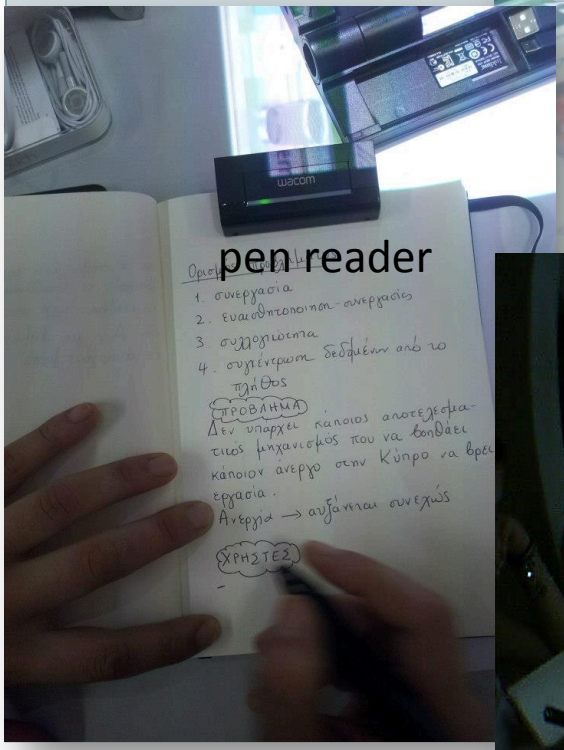


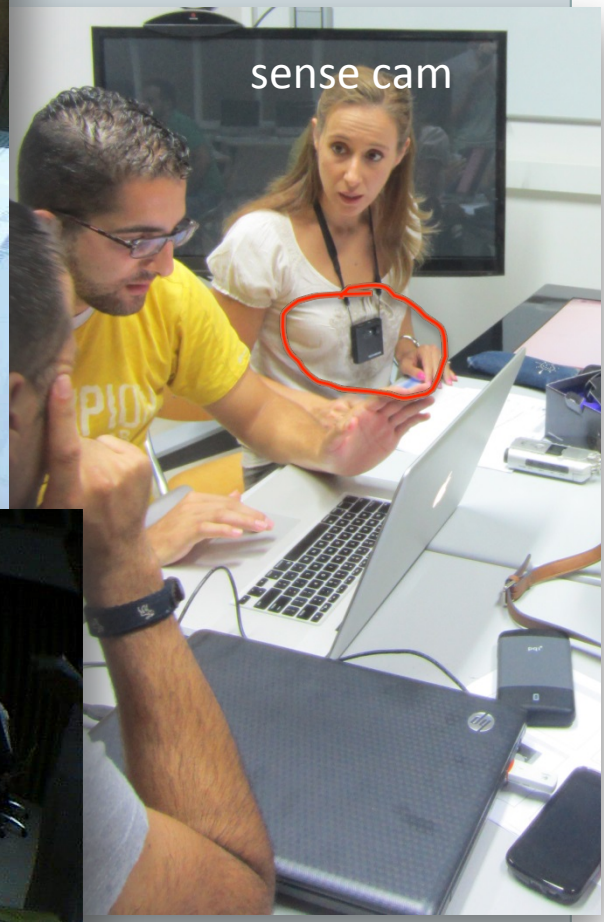


The multimodal information space

2. Portable devices

…and bring your own device!





The multimodal information space

3. Facebook groups

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Methodology

HCI course and participants

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HCI course - 12 weeks, 3-hours sessions

30 participants: 5 groups of 6 students

11 males and 19 females (22-35 years old)

varied backgrounds, multidisciplinary groups

Methodology (2)

Course procedures

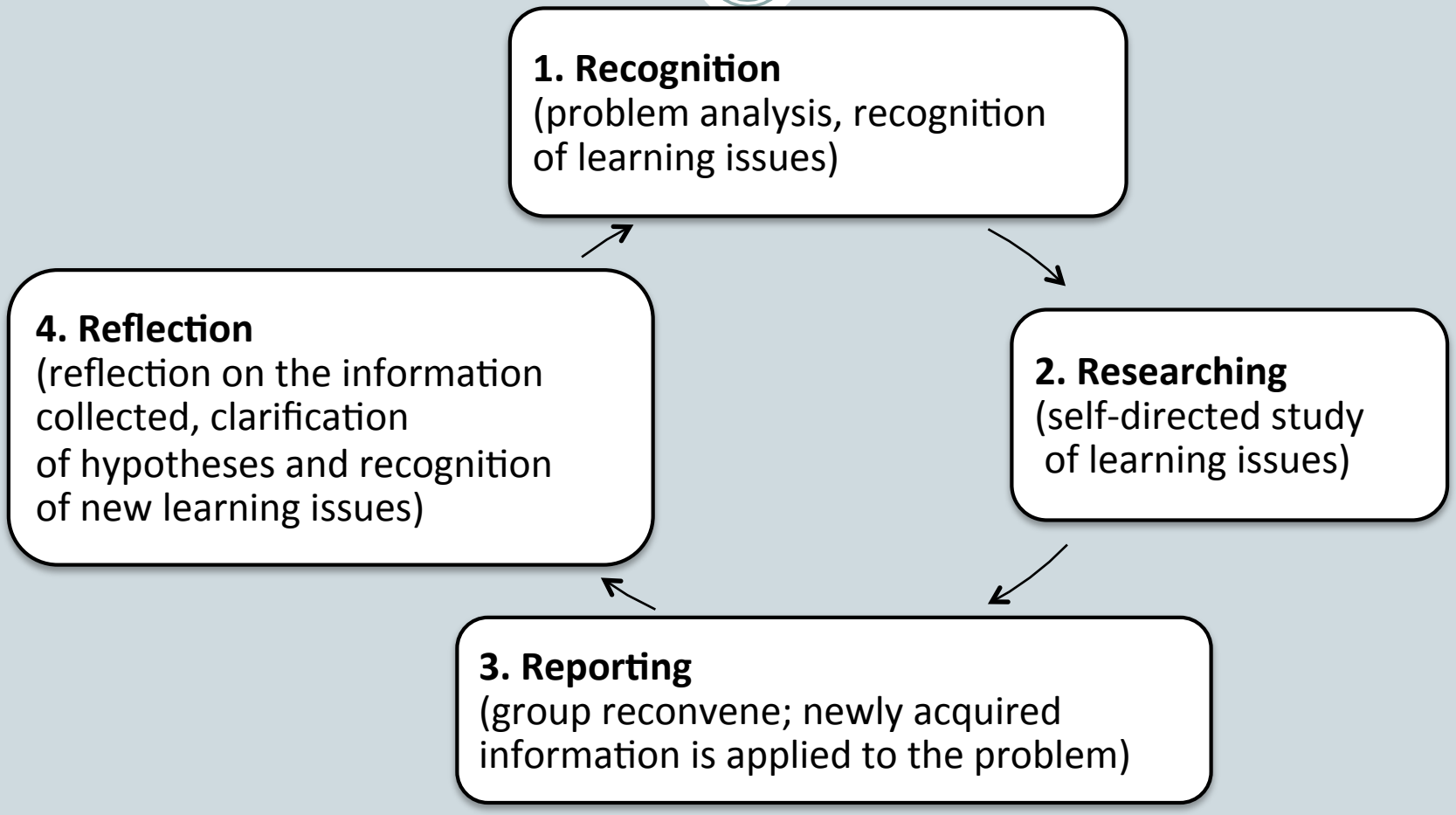
- 1st session
  - hands-on presentation of the technologies, and how we envisioned the information space could be used
  - problem - an authentic need to design an object, interface, system or service that helps "Changing Perspectives Through Collaboration"

    (CHI student design competition, http://chi2013.acm.org/)

- 20-min mini-lecture followed by PBL tutorial
  - Mini lectures on:
    - HCI principles
    - Cognitive psychology and HCI
    - Data gathering and requirements analysis
    - Design process
    - Evaluation (user evaluation, expert evaluation)

Methodology (3)

Course procedures



Phases of problem-based activity
Koschmann & Stahl (1998)

Methodology (4)

Course procedures

1. **Recognition**
- how cognitive psychology can inform design?
- responsibilities for individual research

2. **Researching**
- self-directed study of cognitive aspects of design (e.g., design of displays, information visualization)

3. **Reporting**
- apply knowledge from a human cognition perspective

4. **Reflection**
- evaluate current stage of knowledge
- is there more to be learned from a human cognition perspective?

Cognitive psychology example

Needs analysis example

1. **Recognition**
- what are the needs of the prospective users of system?
- decide 8-10 questions to be answered

2. **Researching**
- conduct interviews and/or observations of prospective users

3. **Reporting**
- present raw data for the needs analysis

4. **Reflection**
- evaluate knowledge
- is there more to be learned on the needs of the prospective users?

Methodology (5)

Data collection

- Quantitative method - 25 Likert-items post questionnaire
  - learners' experiences

    1. Communication and interaction (+)
       e.g., "I explained my ideas to other students"
       "I asked other students to explain their ideas"
    2. Reflection (+)
       e.g., "I thought critically about my own ideas"
       "I thought critically about other students' ideas"
    3. Perceived learning (+)
       e.g., "I learned many things about human-centered design"
       "I believe I can perform well in a similar task in the future"
    4. Satisfaction (+)
       e.g., "I am satisfied with my learning experience"
       "I would recommend this learning environment to the instructor of another course"
    5. Frustration (-)
       e.g., "I felt frustrated", "I felt as though I was wasting my time"

- Qualitative method - focus group data (30-40 min per group) + facilitators' notes/reflections
  - technology adoption and use, support for PBL processes

Results of quantitative analysis

Learners' experience

Subscales and Descriptive Statistics (N=29)

Subscale	# Items	Cronbach's Alpha	Means (SD)
1. Communication and interaction (+)	6	.855	6.16 (.62)
2. Reflection (+)	5	.908	5.79 (.93)
3. Perceived learning (+)	5	.776	6.25 (.75)
4. Satisfaction (+)	5	.927	6.01 (.87)
5. Frustration (-)	4	.789	2.00 (1.22)

*7-point agreement response scale (1: strongly disagree - 7: strongly agree)

Results of qualitative analysis

Thematic analysis of focus group data and facilitators' notes/reflections

Theme 1:
Facebook acted as a record-keeping mechanism, facilitated communication in-between and during meetings and enabled continuity in the interaction

- sharing information and artifacts prepared during self-directed study
- immediate feedback on issues
- trigger discussion during meetings
- record-keeping mechanism for the PBL process

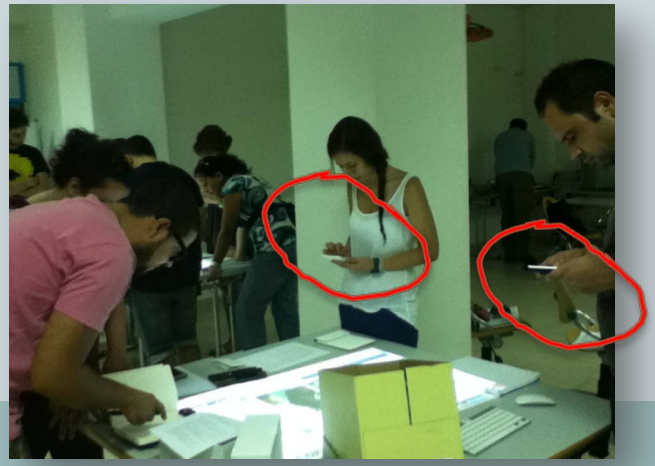
"Facebook was an effective way to communicate in-between class meetings and *during* class meetings. During meetings, we checked whether our to-do list was completed. We had to upload the results of our homework on Facebook. It was an effective way to share all kinds of files in preparation for the meeting. In case someone had a question in completing a step from the to-do list, all of us could provide input via Facebook in a timely manner. At the end of each tutorial we posted a report of our progress and another set of goals for the following week."

Results of qualitative analysis (2)

Theme 2:
Capturing moments and artifacts was beneficial to the PBL process

- Pictures on Facebook facilitated recall of important information, continuity of thought and reflection in action

"Taking pictures and sharing them on Facebook helped me remember what had happened in the previous lesson and even in former lessons and rethink on these activities, like asking myself 'why we acted as we did?' "



Results of qualitative analysis (3)

Theme 3:
Both digital and physical tools were appreciated

"We made extensive use of the digital tools. It was good to also have the pencils and everything; we used post-its and A2 paper during the design of our interface […] We could benefit from more tablets and iPods (maybe a second one) so that we can multitask."

Results of qualitative analysis (4)

Technology adoption and use

All groups used portable devices (mostly smartphones) and Facebook groups

and

Almost all groups used the downward pointing projector and laptops

Adoption of…	Group 1	Group 2	Group3	Group 4	Group 5
Downward-pointing projector	+		+	+	+
Laptops (owned)		+	+	+	+
Facebook	+	+	+	+	+
Smartphones (owned)	+	+	+	+	+
iPod	+		+	+	
Tablet (sometimes owned)	+		+	+	
Sense cam	+ (*)		+		
Pen reader					

(*) Used consistently by a single leaner only

Results of qualitative analysis (5)

Use of technology in PBL phases

- Shared surface with projection and Facebook groups were used in *all phases* of PBL (recognition, researching, reporting, reflection)

- Portable devices for record keeping were mainly used in the *reporting* and *reflection* phases

Results of qualitative analysis (6)

Use of technology in PBL phases

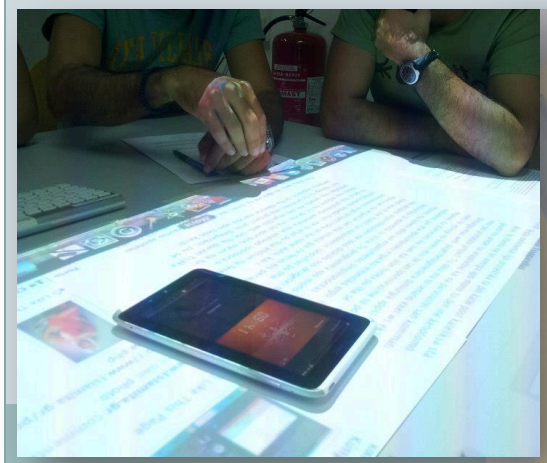
- problem analysis and hypotheses generation around shared surface with projection (recognition)
- Facebook projection provided a trigger for discussion, allowed access to information from previous tutorials (recognition, reporting)
- collaborative researching - Google projection (researching)
- to-do list shared on Facebook (researching)
- new information acquired shared on Facebook (researching, reporting)
- Facebook to renegotiate thoughts and ideas (researching, reporting, recognition)
- captures as source of reflection in the group and individual reflection at home (reflection)

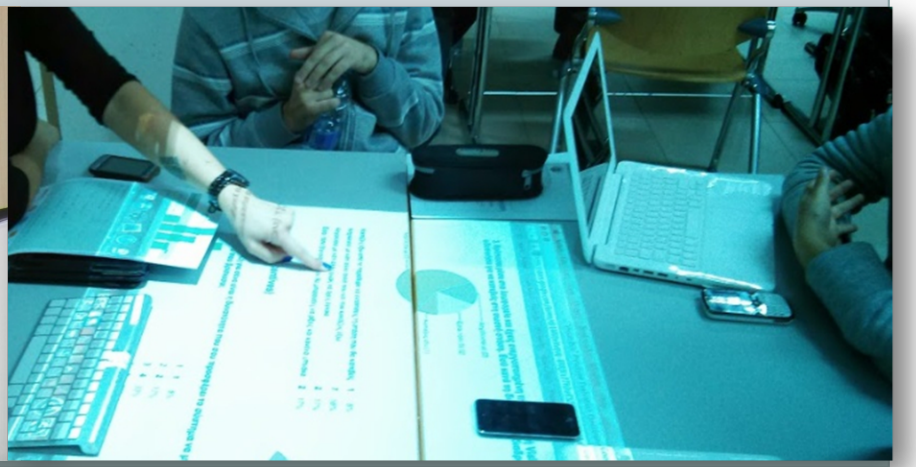
"The downward-pointing projector was great. We could see the screen in large size and there was no need for all of us to sit at the same side of the table. We had our Facebook page opened and looked at our postings from previous weeks, built on those ideas and planned for the day [….] We also google(d) things we needed information about [….] Other times, we projected our wireframe prototypes to work on together."

Some tentative implications

In similar contexts and settings…

- A multimodal learning environment may be taken-up and endorsed by learners
- Facebook may support PBL as a record-keeping and communication tool
- Creative use of available technologies can serve PBL at various stages





Follow up

- Video data are desirable…
  - *when* and *how* and *how often* technology is used
  - *how* technologies influence the individual learner, group collaboration and whole-classroom orchestration
- Ecology of devices and 'blended' interaction across digital and physical tools in the context of PBL
- Contribute towards an evidence-based, design framework on the construction of multimodal information spaces for PBL

Relevant publications & presentations

- Ioannou, A., Vasiliou, C., & Zaphiris, P. (accepted, minor revision requested). Creative multimodal information spaces and blended interaction during problem-based activity in HCI education. *TechTrends.*

- Ioannou, A., Vasiliou, C., & Zaphiris, P. (revision requested). Multimodal learning environments and problem based learning: Experiences, technology adoption and use, and support of PBL processes. *Interdisciplinary Journal of Problem-based Learning*.

- Vasiliou, C., Ioannou, A., & Zaphiris, P. (2014). Measuring Students' Flow Experience in a Multimodal Learning Environment: A Case Study. *Proceedings of HCII 2014.*

- Vasiliou, C., Ioannou, A., Tanja, A., Zaphiris P., & Klobučar, T. (2013). Technology-enhanced Problem Based Learning. Paper presented at the *32nd International Conference on Organizational Science Development*, Portorož, Slovenia.

- Vasiliou, C., Ioannou, A., & Zaphiris P., Tanja, A., Klobučar, T., & Pipan, M. (2013). PBL in HCI teaching: A case study. Paper presented at the 2*nd Interaction Design and Human Computer Interaction Workshop*, Nicosia, Cyprus.

- Vasiliou, C., Ioannou, A., & Zaphiris P. (2013). Technology-enhanced PBL in HCI education: A case study. *Proceedings of INTERACT 2013* (International Conference on Human-Computer Interaction).

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CUT STARTUP FUNDING

Interactive tabletops and decision making in the context of pursuing peace

Interactive Tabletops

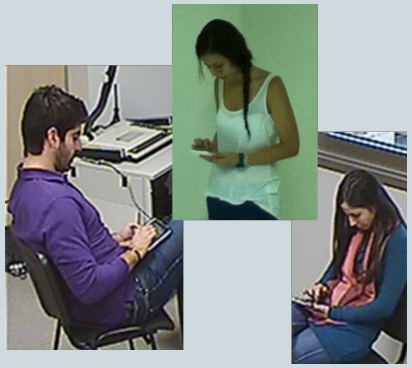
25

- large horizontal displays that enable interaction by multiple concurrent users
- commercially available since 2009 (MS Surface)
- support awareness of others' actions, fluid interaction and coordination (Hornecker, Marshall, Dalton, & Rogers, 2008)
- gesture-based communication can supplement (or even replace) verbal communication (Rick, Marshall, & Yuill, 2011)
- support concurrent input and shared control - groups are able to negotiate conflict (Fleck et al., 2009; Pontual Falcão, & Price, 2009) and engage in 'creative conflict' (Basheri et al., 2013)
- enhance sense of teamwork (Morris et al., 2006)
- 'invite' interaction and willingness to participate (Rogers & Lindley, 2004)
- already substantial work on their use to support learning…
  - summary of work on the pedagogical considerations (Dillenbourg &Evans, 2011)
  - summary of work on technological considerations (Higgins, Mercier, Burd, & Hatch, 2011)

Aim of the study

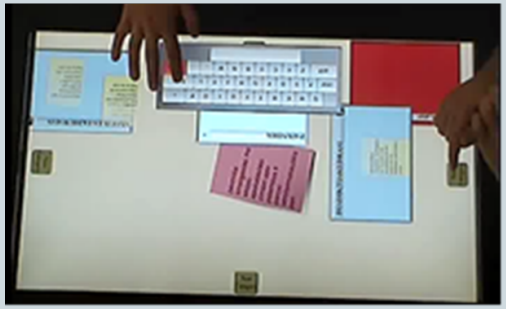
- Views tabletops as peace-enforcing by design and pertinent to bringing people together to resolve conflict
- IdeasMapping tabletop application, designed to facilitate dialog and collaborative decision making
- Activity involved brainstorming, dialog, and collaborative construction of a taxonomy of ideas on the topics of Peace and Immigration
- The study focused on:
  - the systematic assessment of problem-based group collaboration around the interactive tabletop
  - extracting themes relevant to using technology for peace demonstrated across groups

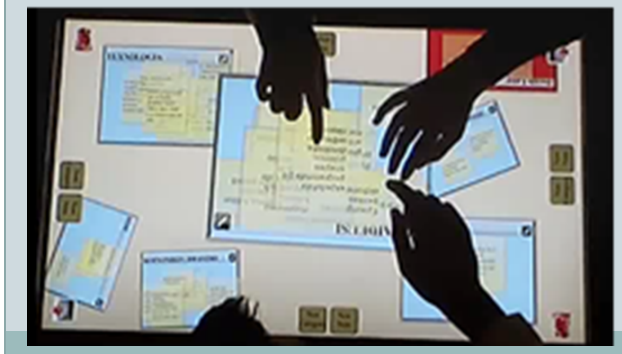
IdeasMapping



Stage 1: With a problem at hand, each collaborator generates new ideas, typed into a web application through the use of a mobile device (brainstorming).

Stage 2: Ideas as digital post-it notes on the tabletop and subject to discussion. Collaborators categorize each idea in a thematic unit - thematic units can be created by any participant (collaborative decision making).





Stage 3: Participants finalize their taxonomy by editing ideas or generating new ideas, deleting ideas or thematic units, and relocating ideas (consensus decision making).

Methodology

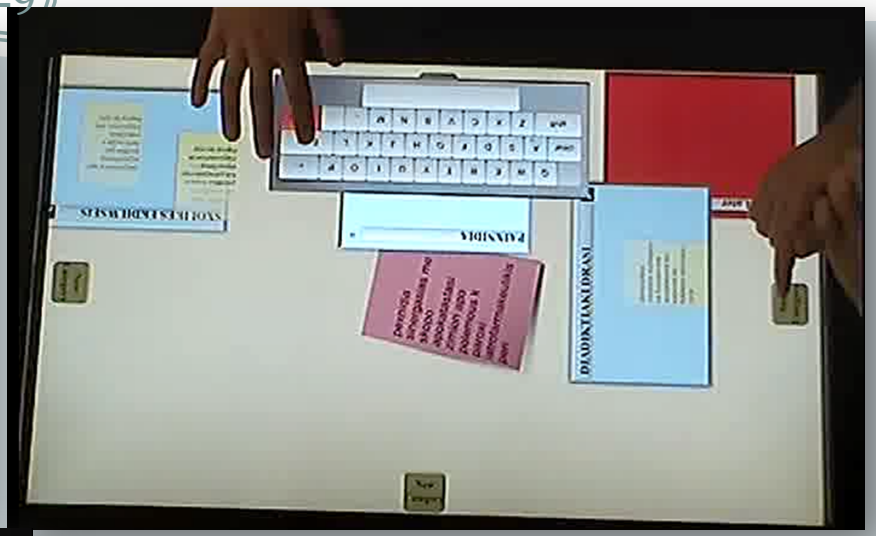
- Participants:
  - 38 BA, MA and PhD students (22-45 years of age)
  - 10 groups 3-4 students each (5 groups per scenario)

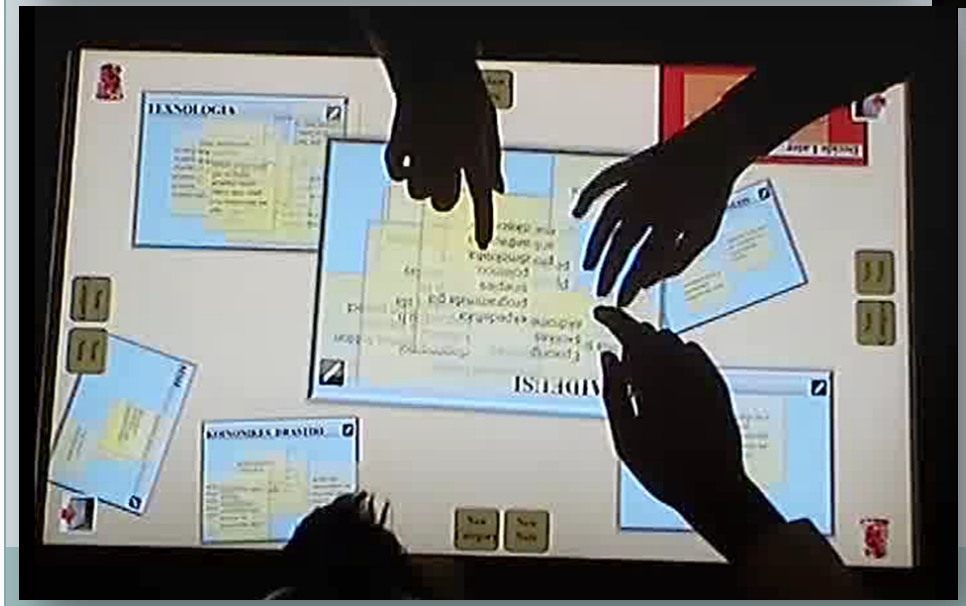
- 2 scenarios: Global Peace and Immigration

'Your team works at a non-governmental organization dealing with global peace. Your project is to create a taxonomy of ideas regarding how we can promote global peace using technology'.

'Your team works at a non-governmental organization dealing with immigration issues. Your project is to create a taxonomy of ideas regarding how we can promote the social integration of immigrants in Cyprus using technology'.

Methodology (2)





IdeasMapping Stages 2 & 3

Taxonomies of how global peace/ social integration of immigrants can be promoted using technology

Analysis and results

30

- Video recordings - 8hs of video (40-60 min per group)
- Systematic video analysis
  - all utterances transcribed for global peace dataset
  - video segmentation; 117 collaboration acts
  - development of a coding scheme (~15% of collaboration acts)
  - independently coded the remaining (85%)
    - % agreement between 2 coders 92%, Cohen's kappa 0.84
  - coding of immigration dataset using same coding scheme
    - 168 collaboration acts, 93% agreement, Cohen's kappa 0.84
  - counting the codes and turns to assess collaboration

1. Systematically developed coding scheme for the assessment of problem based group collaboration around a tabletop
2. Evidence all of the participants were cognitively engaged in the task

Analysis and results (2)

Systematically developed coding scheme with 7 categories of cognitive and physical contributions.

Evidence of applicability of the coding scheme in this context and possibly in other similar contexts.

Cognitive Contributions

1.Proposing – Proposing a new idea or thematic unit

2.Elaborating – Clarifying, Building on previous statements

3.Negotiating meaning – Evaluation of proposal, Questioning/ answering, Expressing agreement/ disagreement, Providing arguments for/against

4.Stating consensus – Summary of ideas, Metacognitive reflections

5.Other talk – Tool-related talk, Social talk, Laughter

Physical Contributions

6.Communicative Gestures – Show on the table without touching, Dominating/blocking gestures

7.Touch Gestures – Resize, Rotate, Type, Move something across, Random touching or touching to explore

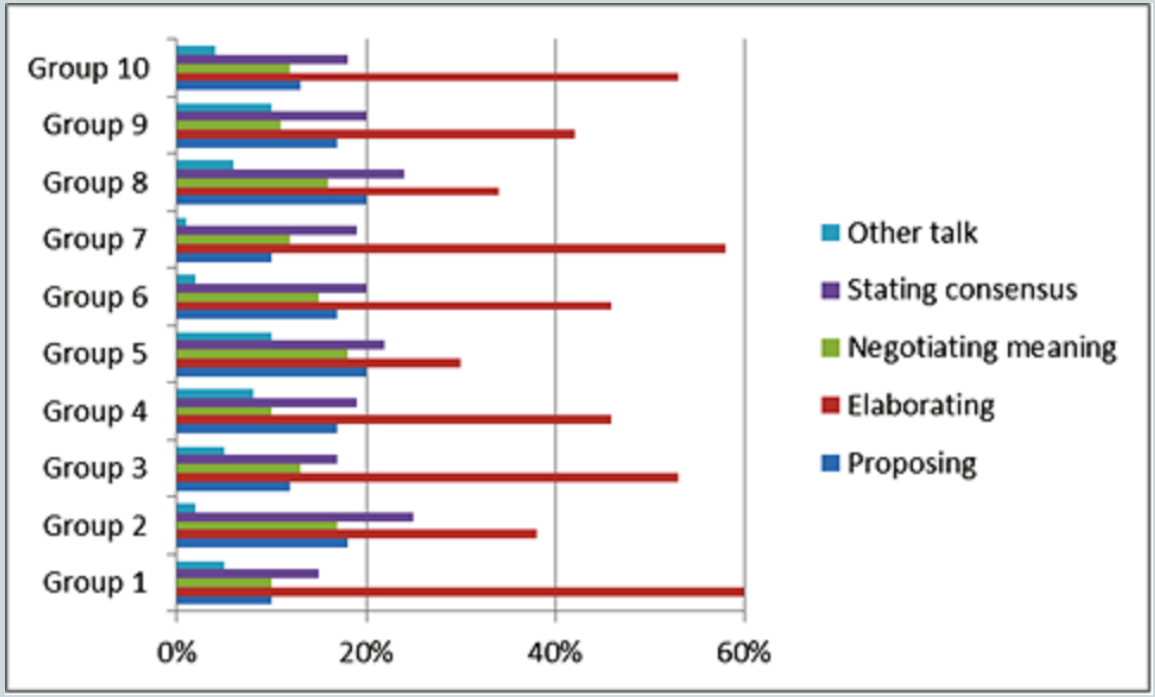
Coding Scheme

Analysis and results (3)

Assessment of collaboration

Evidence the vast majority of contributions were task focused (<10% other talk).

Extended elaboration of ideas, encouraged by IdeasMapping.



Distribution of cognitive contributions across groups

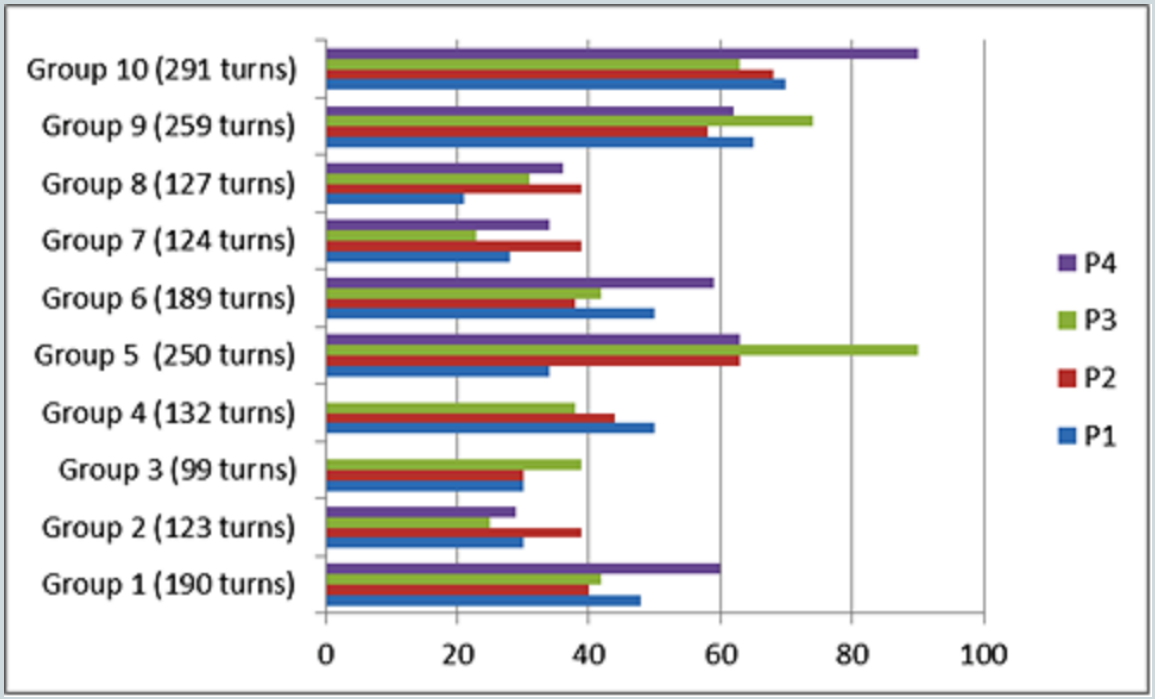
Analysis and results (4)

Assessment of collaboration

Evidence that all group members participated in the task.

Turn-taking behavior was well served by IdeasMapping.

Participation was fairly equal within the groups (chi-square tests).



Participants' turn-taking behavior

Analysis and results (5)

Themes on technology for peace

Technology for Peace (ways of using technology for…)	• information sharing and raising awareness.(5) • peace education.(4) • conflict management.(3) • diminishing inequalities.(3) • organizing events.(5)
Technology for Immigrants' Integration (ways of using technology for…)	• intercultural education.(5) • communication.(5) • providing services and information sharing.(4) • organizing events/entertainment.(3)

Consistent themes contributed across groups

Meta-review:
Across peace and immigration scenarios all ideas can be consolidated into three dimensions:

1. the use of technology to promote peace-related outcomes
2. the use of technology to promote empowerment
3. the use of technology for understanding conflict

Some tentative implications

1. Our systematically developed coding scheme for the assessment of problem based group collaboration around a tabletop can be applied (and extended) to more studies in the area.

2. The consistent themes and ideas contributed across groups highlight a number of areas where research could focus in terms of using technology for peace.

3. Interactive tabletops appear pertinent to bringing people together to resolve conflict
   - Cases of tabletop collaboration with conflicting parties and sensitive/controversial issues are worth exploring.

4. The study calls for further research on peace and technology taking advantage of current technologies that are 'peace-enforcing' by design.

Follow up

- ✓ Potential of tabletops
  in conflict resolution/ breaking down barriers
  - ✓ school research with students
    in conflict working together
    around the tabletop

Follow up (2)

- ✓ Tabletops in pre-service teacher education: collocated collaboration, coordination, structure and organization of ideas during case-based learning.

- ✓ Integrating tabletops in multimodal classrooms

Relevant publications & presentations

- Ioannou, A., Zaphiris, P., Loizides, F., & Vasiliou, C. (2013). Let's talk about Technology for Peace: A systematic assessment of problem-based group collaboration around an interactive tabletop. *Interacting with Computers*. doi:10.1093/iwc/iwt061.

- Zaphiris, P., Ioannou, A., Loizides, F., & Vasiliou, C. (2013). User experience in using surface computing for collaborative decision making. *Interactive Technology and Smart Education, 10* (4).

- Ioannou, A., Zaphiris, P., Loizides, F., & Vasiliou, C. (2013). Mapping Peace Ideas around the Table. In C. Stephanidis (Ed.), Proceedings of HCII 2013, Communications in Computer and Information Science (Vol., 374, pp. 52-56). Springer.

- Ioannou, A., Zeniou, M., & Georgiou, A. (2014). Dialogue, knowledge work and tabletops: Lessons from preservice teacher education. *Proceedings of HCII 2014.*

- Zaphiris, P., Ioannou, A., Loizides, F., & Vasiliou, C. (2012, October). Ideas Mapping, surface computing and user experience. Proceedings of the International Workshop on the Interplay between User Experience (UX) - Evaluation and System Development (I-UxSED 2012) part of NordiCHI 2012, Leicester, UK

- Ioannou, A., Zaphiris, P., & Loizides, F. (2012, March). Mapping ideas around the table. Paper presented at the 12th Workshop on Surface Learning, Bristol, UK.

Within technology-enhanced learning…

Future directions:

- Explore how the augmented use of physical tool, digital tools (mobile devices, tabletops, mixed reality wearable etc) and virtual interactive spaces can support collaboration and physical interaction around problem-based activities.
- Explore tabletops as a peace-enforcing technology capable of promoting social-perceptive taking and conflict resolution.
- Explore tabletops as means to support collaborative learning and knowledge creation in collocated settings (co-located CSCL).

Thank you

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- The Cyprus Interaction Lab
- Participants in my research