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Let'S Talk About Technology for Peace: A Systematic Assessment of Problem-Based Group Collaboration Around an Interactive Tabletop

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This work is concerned with the exploration of ideas in the realm of technology for peace, produced by small groups of students working around an interactive tabletop. A collaboration-enforcing tabletop application was used to mediate dialog and collaborative construction of a taxonomy of ideas based on the participants' consensus. The scenarios for discussion concerned the promotion of global peace and the social integration of immigrants in the society. The participants' dialog and interactions were video-recorded and analyzed. The study contributes a systematically developed coding scheme capturing the cognitive and physical elements of problem-based group collaboration around the interactive tabletop. Also, the consistent themes and ideas contributed across the participating groups highlight a number of areas where research could focus in terms of using technology for peace.

RESEARCH HIGHLIGHTS

- We focus on ideas in the realm of technology for peace, which is a domain of interest but rarely addressed in the field.
- We use multi-touch tabletop technology as a means for promoting dialog and collaboration on a group artifact.
- We conduct a systematic video analysis of interactions and present a coding scheme of problem-based group collaboration around an interactive tabletop.
- The themes and ideas contributed across the participating groups highlight areas for research in the realm of technology for peace.

Keywords: empirical studies in HCI; tables and interactive surfaces; collaborative learning; collaborative content creation

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1. INTRODUCTION

Peace and immigration are prominent, sensitive issues and well-studied phenomena in the social sciences. Yet, the learning/education and Human Computer Interaction (HCI) communities are far behind with engaging in relevant empirical research. Within a humanitarian approach to education, 'technology-infused peace initiatives rely predominantly on targeting antecedents to peace, such as collaboration, interaction, communication, and understanding of the "other", rather than peace itself' (Veletsianos and Eliadou, 2009, p. 63). Within the HCI community, little time and effort have been devoted to the development of technologies with the explicit goal of preventing conflict and promoting peace (Hourcade, 2009).

Some interest related to peace and the role of technology has started to appear recently (e.g. Hourcade and Bullock-Rest, 2011; Hourcade *et al.*, 2011, 2012; Zancanaro *et al.*, 2012). As Hourcade and Bullock-Rest (2011) suggest, there are many opportunities for research in the area of HCI and Peace including 'the design of technologies to enable connections between opposing camps, tools to present news stories from several points of view, and technologies to support international monitoring missions to prevent the escalation of conflicts' (p. 443).

Meanwhile, multi-touch interactive tabletops have been extensively discussed in the HCI and learning communities for their potential to support collaboration and learning. In addition to the already researched affordances of the technology (e.g. enhancing sense of teamwork (Morris *et al.*, 2006), increasing engagement in 'creative conflict' (Basheri *et al.*, 2013), 'inviting' interaction and willingness to participate (Rogers and Lindley, 2004), etc.), this work considers the technology as 'peace-enforcing' by design and pertinent to group work on peace-related tasks. That is, the technology allows for participants' 'power' to be shared and distributed over a shared display, while it directs attention to a shared goal (Fleck *et al.*, 2009). Friedman *et al.* (as cited in Hourcade, 2009) found that, in conflict situations, people who take into account the interests of all parties experience less conflict than those who attempt to dominate. In this sense, the distributed 'power' over a shared tabletop display 'forces' the participants to take into account the interests of the 'other'.

Definitions of 'peace' abound (see review by Veletsianos and Eliadou, 2009). Adhering to a single definition was not intended in this work. Rather, the present study is concerned with the exploration of general ideas in the realm of technology for peace, produced by small groups of students working around an interactive tabletop. The activity involved brainstorming, dialog and collaborative construction of a taxonomy of ideas on the use of technology for peace. In this sense, technology for peace was inclusive of discussion of any intervention or tool aimed at 'promoting interfaith dialog, multicultural communication and understanding, and respect for diversity' (Veletsianos and Eliadou, 2009, p.64). We explored two research directions:

— How can we systematically assess problem-based group collaboration around an interactive tabletop?
— What themes relevant to technology for peace are demonstrated across groups?

We start by covering related research literature and continue with a brief report on the functionality of the application and its use in our empirical investigation. The paper concludes with a discussion of the key findings and implications of this work for future research and practice.

2. EXISTING KNOWLEDGE

2.1. Technology for peace

The most recent systematic review on the use of technology to promote peace and humanitarianism was conducted by Veletsianos and Eliadou (2009). The review revealed that a few (educational) technologies have been used in interventions associated with the promotions of peace such as: (i) learning management systems and virtual learning environments to host learning activities, (ii) Web 2.0 technologies (blogs, wikis, social networking sites and video sharing sites) as well as email and video conferencing to promote collaboration communication, diversity and international cooperation between conflicting parties and (iii) online and video (serious) games and MMORPGs to promote exposure to diverse populations and collaborative learning through social interaction (e.g. the PeaceMaker video game by Burak *et al.* (2005), which simulates the Israeli–Palestinian conflict and engages learners in negotiating peace), among other technologies (see review by Veletsianos and Eliadou (2009)). Yet, the discussion on how to use technology to promote global peace seems to revolve mainly around internet technologies, while the use of technology in collocated settings is relatively unexplored.

There is a very limited amount of studies exploring collocated collaboration in the domain of peace. One example is Stock *et al.*'s (2008) design of a multi-touch tabletop application for joint narration, as a tool for reconciliation between two conflicting sides. The so-called Negotiation Table allows multimedia narrations to be contributed from both sides, who then act jointly toward achieving a narration acceptable to both viewpoints (i.e. by revising and completing the narration together). Initially, the interface was used by Jewish–Arab pairs of youth; it was found successful in helping young people from the two sides reach a compromise and all participants expressed a general satisfaction (and sometimes even a surprise) with learning more about their partner's viewpoints (Stock *et al.*, 2008). In a follow-up investigation, the interface was used with 39 pairs of Jewish–Arab male youth with similar positive findings (Zancanaro *et al.*, 2012).

2.2. Tabletops and collaboration

The potential of multi-touch interactive tables to support collaboration and group work has been discussed in a few studies to date. A table that handles multiple simultaneous touch inputs is considered to enable collaboration by allowing different patterns of turn taking, negotiation and interaction (Harris *et al.*, 2009; Buisine *et al.*, 2012). Furthermore, it has been suggested that multi-touch tabletops enhance users' sense of teamwork (Morris *et al.*, 2006), increase learners' engagement in 'creative conflict' (Basheri *et al.*, 2013), 'invite' interaction and willingness to participate (Rogers and Lindley, 2004), increase equity in physical interaction compared with

other devices (Marshall *et al.*, 2008), promote joint attention on the task (Fleck *et al.*, 2009; Higgins *et al.*, 2011), encourage playfulness in interaction (Piper and Hollan, 2009; Jamil, 2011) and improve the (learning) experience and motivation to engage in the task (Buisine *et al.*, 2012; Ioannou and Christofi, 2013) among others.

A variety of applications have already been developed for multi-touch tabletops to research how children and adults interact around this technology and how it can support collocated collaboration in educational settings. One such application is the StoryTable, which was found to enforce cooperation during storytelling activity and the development of narratives with high cohesion (Cappelletti *et al.*, 2004). Another one is OurSpace, engaging young children in a collaborative design of a seating plan for their classroom (Marshall *et al.*, 2009). Studies of OurSpace provided evidence for the added value of a multi-touch interface compared with a single-touch interface with regard to the quality of talk. In particular, the researchers found that children engaged in more task-focused talk in the multi-touch condition and more turn-taking talk in the single-touch condition (Harris *et al.*, 2009). More recent investigations of OurSpace have discussed mechanisms for coordinating joined attention and collaboration during tabletop interaction (Fleck, 2009). For example, joint attention can be maintained using techniques such as 'undoing' of others' actions and allowing for intrusions (Fleck, 2009), as well as enforcing turn-taking and joint-actions (Piper *et al.*, 2006; Piper and Hollan, 2009). Furthermore, a series of studies have been conducted by the SynergyNet project team, focused on tabletop collaboration and learning within small groups in K-12 (Higgins *et al.*, 2011). The researchers contrasted groups of children in multi-touch and paper-based conditions to examine the differences in their collaborative learning strategies and found that groups in the multi-touch condition maintained better joint attention on the task (Higgins *et al.*, 2011). Last but not least, in higher education, Basheri *et al.* (2013) found that a collaborative design application (UML diagramming) running on a multi-touch tabletop allowed for increased physical interaction, learner engagement and 'creative conflict' (i.e. arguing and disagreeing directed at ideas rather than people), compared with a same application running on a PC.

2.3. Understanding collaboration around the tabletop

To date, very few papers present a systematic classification of participants' dialog and interactions around a tabletop. Where such an analysis is presented, the focus is on the physical interaction patterns aiming to inform the design of the collaborative interface, for example, coding the styles of collaborative coupling (Tang *et al.*, 2006), coding the behaviors relevant to orientation (Kruger *et al.*, 2004) and coding the behaviors relevant to awareness (Hornecker, 2008), whereas the verbal interactions are of less concern in most tabletop studies. A systematic classification of discourse (verbal) categories was undertaken in only a couple of recent studies such as Shaer *et al.*'s study (2011) of genomic learning around tabletops and Jamil *et al.*'s (2011) study of communication patterns around different kinds of tabletop interaction techniques. Yet, a coding scheme capturing the kinds of discourse and interactions during tabletop collaboration on problem-based scenarios is currently lacking.

Previous collaborative learning research has contributed coding schemes mainly for the small group interaction in distributed learning settings (see, for example, the review of coding schemes by De Wever *et al.*, 2006). In this case, successful collaborative discourse is generally characterized by (i) contributions of content and ideas related to the group task, (ii) reflections and cognitive and meta-cognitive exchanges (asking question, exchanging conflicting opinions and providing explanations) and (c) evidence of knowledge construction, i.e. having new insights as a result of the discussion, making connections and synthesizing information (e.g. Hmelo-Silver, 2003; Stahl, 2006). Although it would make sense that good collaboration in distributed learning settings would share similar characteristics with good collaboration around tabletops, there is less (if any) evidence of a systematic analysis of the participants' dialog and interactions in the second.

In sum, this study aimed to explore ideas in the realm of technology for peace; a domain of interest to the learning and HCI research communities, but for which research is lacking. On the basis of a previous work, we deemed a multi-touch interactive tabletop to be the most suited interface to the objectives of this study, providing a shared workspace for co-located collaboration and coordination for the discussion of peace ideas. In addition to the affordances of the technology discussed earlier (e.g. enhancing sense of teamwork, increasing learners' engagement in 'creative conflict', etc.), we consider the technology as 'peace-enforcing' by design. That is, the technology allows for participants' 'power' to be shared and distributed over a shared display (vs. issues of power leading people to conflict and war), while it directs attention to a shared goal (Fleck *et al.*, 2009). It thus, becomes pertinent to mediating talk about peace. Overall, we explored two research directions:

— How can we systematically assess problem-based group collaboration around an interactive tabletop?
— What themes relevant to technology for peace are demonstrated across groups?

3. METHOD

3.1. Participants

A total of 38 students (Greek Cypriots) from a public university in Southern Cyprus voluntarily participated in this study. These were BA, MA or PhD students aged between 22 and 45 years

Figure 1. Students typing initial ideas for discussion.

(M = 28). The participants formed 10 groups of 3–4 students per group, suitable for a four-sided multi-touch tabletop.

3.2. The tabletop application

Ideas Mapping is a tabletop application designed to support idea generation, collaborative decision-making and group artifact construction. The application allows the participants to analyze a problem and actively construct a taxonomy of their ideas based on their consensus on how to tackle the given problem. The application builds on the principle of Affinity Diagramming—an HCI technique used to facilitate discussion and collaboration in groups and to extract ideas from users' initial conceptual models. The technique lets users write down items of knowledge or descriptions on sticky notes and then organize the notes into groups before creating group headings. It is enforced in small teams usually working on a shared whiteboard or large piece of paper (Zaphiris *et al.*, 2013).

3.2.1. Ideas mapping works in three stages

Stage 1 Each collaborator generates initial ideas for discussion (i.e. brainstorming) concerning how to tackle a given problem. Ideas are typed into a web application through the use of a mobile device such as a laptop or tablet (see Fig. 1).

Stage 2 The ideas are presented one-by-one, as digital post-it notes in the middle of the tabletop surface, and become subject to discussion among the collaborators (i.e. negotiation). Post-it notes are randomly presented and automatically oriented to face their contributor 'inviting' him/her to elaborate on the idea. This feature aims to encourage turn taking (e.g. Piper *et al.*, 2006; Piper and Hollan, 2009), as well as to enable democratic decision-making by allowing equal opportunities for everyone to share and clarify their ideas. Upon discussion of each idea, collaborators make an effort to categorize it in a thematic unit—thematic units can be created by any participant (Fig. 2).

Stage 3 Participants finalize their taxonomy by editing ideas or generating new ones, deleting ideas or thematic units that are less promising and relocating ideas into thematic units for a better fit (i.e. negotiation and collaborative construction of a group artifact). The application encourages 'undoing' of others' actions and re-thinking of the placement of the ideas, thus promoting joint attention and awareness (e.g. Fleck *et al.*, 2009). The resulting taxonomy reflects the participants' consensus on how to tackle the problem (Fig. 3).

3.3. Procedures

There were two problem-based scenarios in the study. Five groups participated in the global peace scenario and another five participated in the immigration scenario.

The scenario for the global peace study was: 'Your team works at a non-governmental organization dealing with global peace. Your project is to create a taxonomy of your ideas regarding how we can promote global peace using technology'. This topic was considered to be personally important to our participants and one that could elicit their mental engagement. This is because Cyprus is a country in a long lasting ethnic conflict where Turkish Cypriots (T/Cs) live in the northern part of the island and Greek Cypriots (G/Cs) live in the southern part, since 1974. Until recently, citizens of the two communities have not been allowed to freely cross the ceasefire line, controlled by the United Nations Force in Cyprus. In the last few years, restrictions have been lifted, but real communication and face-to-face interaction between T/C and G/C is still limited. Because

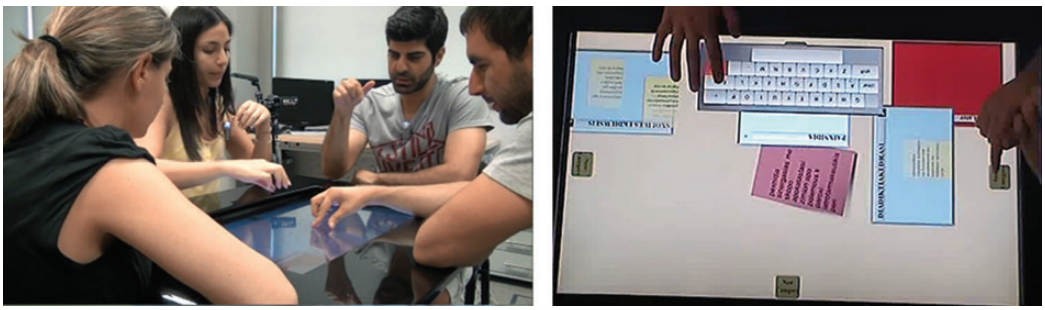

Figure 2. Categorization of ideas in thematic units.

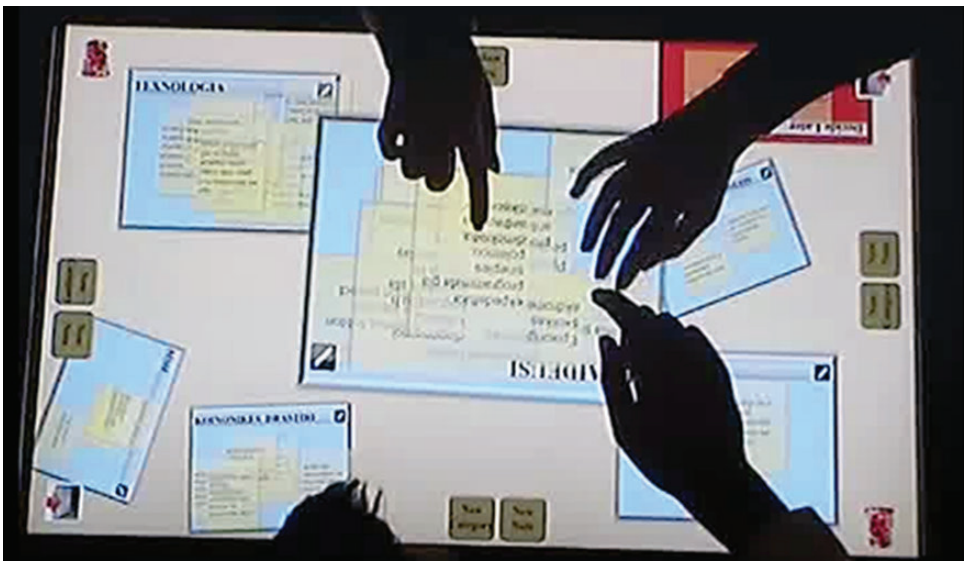

Figure 3. Finalizing consensus taxonomy of ideas.

discussing ethnic-related issues in Cyprus often leads to tension, anxiety and strong disagreement (linked to politics), in this study we avoided framing the topic as 'Peace in Cyprus'. Instead, we used the high level topic of 'global peace' assuming it remained personally important to our participants.

The scenario for the immigration study was: 'Your team works at a non-governmental organization dealing with immigration issues. Your project is to create a taxonomy of your views and ideas regarding how we can promote the social integration of immigrants in Cyprus using technology'. Cyprus is a country experiencing increased immigration during the last two decades, with a large part of its human resources and population in general, now being non-Cypriot. This has caught the Cyprus society unprepared for the challenges and opportunities that immigrants bring to the island, while the ever-growing incidents of xenophobia, discrimination and racism become a great concern. As such, promoting the immigrants' social integration was also considered personally important to the Cypriot participants of this study.

Stage 1 of Ideas Mapping was completed in distance, during the week before students engaged in group work. This preparatory week aimed to allow students to think about the given scenario at their own pace and record their initial ideas into the Ideas Mapping web application. The rest of the activity involved co-located collaboration around the tabletop. Each group met face-to-face and engaged in collaborative work as described in Stages 2 and 3 of Ideas Mapping. Students engaged in discussion and physical interaction with the tabletop in an effort to categorize the different views and ideas into thematic units (Stage 2, see Fig. 1) and to finally construct a taxonomy of how global peace/social integration of immigrants can be promoted using technology (Stage 3, see Fig. 3).

The sessions of all groups were video-recorded for subsequent analysis. Approximately 8 h of video was recorded,

with groups taking between 40 and 60 min to complete the task.

4. ANALYSIS AND RESULTS

Later we provide details on how we conducted a systematic video analysis of interactions resulting to a coding scheme of problem-based group collaboration around an interactive tabletop. We then describe how collaboration was further assessed using a coding-and-counting approach. Last, the taxonomies constructed by the groups were evaluated for consistent themes pertinent to technology for peace.

4.1. Video analysis and coding scheme

All utterances and physical actions in the global peace dataset (Groups 1–5) were transcribed to assist further coding. Then, two researchers worked closely together to segment the video corpus into collaboration acts (i.e. units of meaning); 117 collaboration acts were defined to exist.

Typically, a collaboration act involved the discussion of an idea until a decision was made about its placement in (or deletion from) a thematic category. For example, in Stage 2, ideas were typically explained by their originator and then all group members engaged in clarifying, discussing and categorizing the idea. As such, almost every new idea in Stage 2 produced a collaboration act, as illustrated later (Group 4). Then in Stage 3, ideas and categories were revisited in order to be refined, thus leading to more collaboration acts.

P1: 'Online protest against human rights violations' (P1 reads the post-it note aloud).
P3: But how?
P1: Online. . . using forums to scheduled online events.
P3: Can we categorise this as 'tech for information sharing' [category title]?
P1: No, not 'information sharing'. I see it as a social event to help raise awareness.
P2: Yes, 'tech for planning social events'. Sharing information is one thing and organizing an online protest is another thing.
P3: True.

The two researchers used ∼15% of the collaboration acts for the development of the coding scheme in context (i.e. on the basis of the video data). The coding scheme of the study is illustrated in Table 1; it includes seven categories of cognitive and physical contributions around the tabletop.

Following the development of the coding scheme, the two researchers independently coded the utterances and physical actions of the remaining (85%) of the collaboration acts. The percent agreement between the coders was 92%, and the Cohen's kappa statistic (a chance-corrected index of agreement) was 0.84.

Table 1. Coding scheme—cognitive and physical contributions around the tabletop.

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

Table 2 presents short transcripts of collaboration acts to demonstrate how the coding scheme was applied and what aspects of the video content constitute evidence for each coding category. As shown later, the categories were not mutually exclusive; that is more than one code could be assigned to a collaboration act. Proposing and elaborating, for example, often occurred together when participants aimed to explain their ideas to others. Moreover, cognitive contributions were, almost always, accompanied by physical contributions, mainly communicative gestures to ground them, consistent with Fleck *et al.'s* (2009) finding that children's talk and physical gestures were commonly coupled during group work in OurSpace.

The same two researchers proceeded with coding the verbal and gestural contributions in the videos of the immigration scenario (Groups 6–10), after transcription of the corpus and segmentation into collaboration acts (168 collaboration acts). The coding scheme of Table 1 fitted the new data corpus well, suggesting the applicability of the coding scheme in this context and possibly in other similar contexts. The agreement between the coders was again high (93% agreement, Cohen's kappa = 0.84).

4.2. Assessment of collaboration via counting the codes and turns

The tabletop collaboration was further assessed by counting the cognitive and physical contributions in each group, as well as quantifying the turn-taking behavior.

Figure 4 presents the distribution of cognitive and physical contributions across groups. The result provides evidence that the vast majority of contributions were task focused. In particular, the 117 and 168 collaboration acts found in the peace and immigrations videos, respectively, involved cognitive

Table 2. Application of the coding scheme.

Coding	Collaboration act (unit of analysis)	Comments
Proposing	P1: 'Diminishing of digital divide' (P1 reads post-it note aloud). I was thinking here that access to technology and especially the Internet is linked to the educational level of the people, and it is also somehow linked to whether the county is developed, developing or underdeveloped. I am thinking that getting people access to technology helps them develop and be equal, and this promotes peace indirectly (touch gestures and communicative gestures occur).	Some ideas were proposed and elaborated by their contributor, then accepted and acknowledged without further negotiation (Group 3, Stage 2).
Elaborating Gestures	P3: I see what you are saying.	
Stating consensus	P2: Very good idea, I would put it in the 'Equal Rights and Access' category (touch gestures occur while P2 categorizes the idea)	
Proposing	P1: 'September 25th is the World Day of Peace' (P1 reads post-it note aloud; touch gestures occur).	Yet, it was not also usual for ideas to be questioned and evaluated more critically (Group 3, Stage 2).
Negotiating Meaning	P2: But where does the technology come in this idea? P1: You may use technology for the promotion of this day, which many of us don't know! (Communicative Gestures) P3: It reminds me of Google. It changes its logo to celebrate some days of the year. This is in fact a very good idea.	
Stating consensus	P1: Now I see . . . but the use of technology was not clear initially. P2: Well, I made it clear now (laughter). P1: How should we categorize it? It is quite general. 'Tech for informing?', 'Tech for promoting events?'	
Gestures	[. . .]	
Negotiating Meaning	P1: 'Protest via technological means' (P1 reads the category title aloud; touch gestures occur). P2: 'collecting signatures', 'discussing events of violence' . . . (P2 reads aloud ideas categorized here). P1: We need to remember the topic continuously . . . promoting global peace using technology. 'Protest via technological means'. Is this a way of promoting peace? P3: Wait a minute. What [ideas] do we have in here? P1: 'commenting on violence on forums and wikis' . . . (P1 reads more ideas aloud).	Ideas and their placement in particular categories were critically evaluated in Stage 3, for example here Group 4 reviewed the ideas within a category to ensure good fit.

continued.

Table 2. continued.

Coding	Collaboration act (unit of analysis)	Comments
Stating consensus	P3: Should we change the title [of the category] to 'tech for information exchange' or something?	
	P1: 'tech for communication' is better.	
Gestures	P2: Yes, better.	
Proposing	P2: 'Use social networks to organize a flashmob event to support global peace' (P2 reads post-it note aloud).	Limited off task talk was present in all groups, often together with cognitive contributions (Group 2, Stage 2).
Negotiating	P4: What is a flashmob?	
Meaning	P2: Let me explain (smile). Basically we can create teams in a blog, and these teams will meet one day to perform in the middle of an avenue. They may be signing, acting…	
Other Talk	P1: Are you distracted by '[famous singer's name]' (laughter)	
	P2: I am serious, I have seen this! My daughter participated, and my cousin and other I know (laughter).	
	P3: Is this a social event?	
	[. . .]	

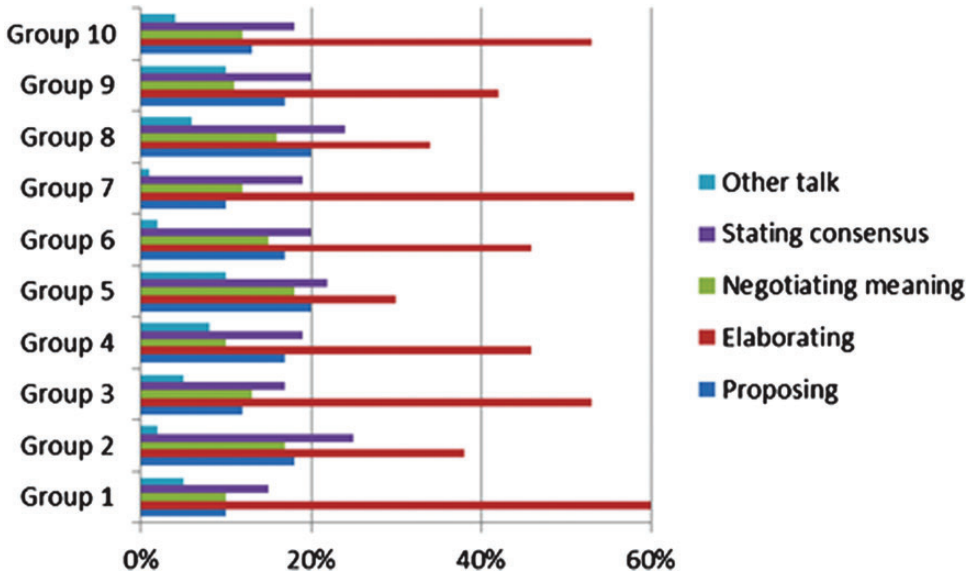

Figure 4. The distribution of cognitive contributions across groups.

elements (e.g. proposing ideas, elaborating, questions and answers), almost always accompanied by communicative and touch gestures. Instead, off-task talk (e.g. social, laughter) was <10% of the discourse in each group. It is also worth pointing to how most of this cognitive talk involved elaboration of ideas, which was encouraged by the application and the orientation of the ideas to face their contributor (Stage 2).

Furthermore, Fig. 5 presents the participation of the individual group members in terms of turn taking (Groups 1–5 for global peace and Groups 6–10 for immigration); that is, we counted the number of times each individual 'spoke' during the discussion of the scenario and construction of their group taxonomy (40 to 60 min depending on the group). The result provides evidence that all group members participated in the task and that turn-taking behavior was well

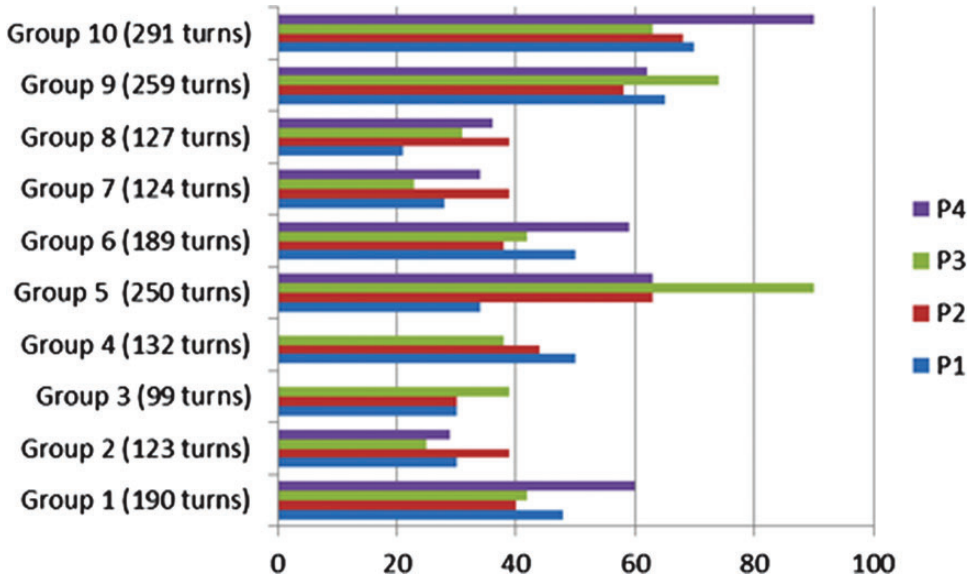

Figure 5. Participants' turn-taking behavior.

served by Ideas Mapping. Perhaps more important is that participation was fairly equal within the groups as shown by a series of chi-square-goodness-of-fit tests (chi-square values between 1.6 and 5.8 with P value >0.05), with the exception of only one group (Group 5 discussing peace) that had statistically significantly unequal participation at 0.01 alpha level ($\chi^2(3) = 25.1$, $P < .001$).

With our systematic development of a coding scheme, followed by counting the codes and turns, we assessed problem-based group collaboration around an interactive tabletop. In sum, we have evidence that all participants were able to cognitively engage in the task for the duration of the activity.

4.3. Themes across the taxonomies

The taxonomies constructed by the groups were explored for consistent themes with regard to possible uses of technology for the promotion of global peace and social integration of immigrants in Cyprus. For both global peace and immigration scenarios, there was a significant overlap in the general thematic categories formulated across groups and the ideas included within the categories. Of course, each group had a few unique ideas and in a few cases, similar ideas were categorized differently by different groups, as a result of the negotiation process and the views of the participants in the group. In Fig. 6, we present the consistent themes contributed across groups (by 'consistent' we mean themes presented in the taxonomies of at least three groups—see parentheses in Fig. 6 for the number of groups having the theme). Also, Tables 3 and 4 list the most persistent and discussed ideas within these themes.

Finally, we conducted a meta-review of the themes and ideas across both studies—peace and immigration. We found

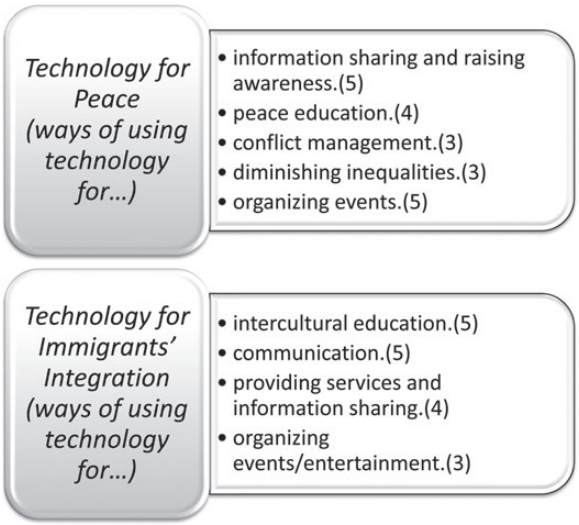

Figure 6. Themes across taxonomies.

that all ideas revolve around, and can be consolidated into, three larger dimensions: (i) the use of technology to promote peace-related outcomes, for example, the use of YouTube to broadcast favorable images of the 'other' (foe or immigrant) and to promote awareness of their culture, (ii) the use of technology to promote empowerment, for example, enabling access to technology in order to 'include' the children of the developing world/immigrants and enable a means for them to learn and be included and (iii) the use of technology for understanding conflict, for example, promoting discussion and collaboration on conflict resolution among the conflicting parties using weblogs, wikis, etc.

Table 3. Persistent ideas on using technology for Global Peace.

Theme	Most persistent and discussed ideas
Using technology for information sharing and raising awareness.	• Host new web pages about world peace • Start a mailing list to distribute messages about world peace • Produce and share YouTube videos on world peace • Start forums, blogs and social networks for the discussion of peace and the distribution of multimedia content related to the consequences of war
Using technology for peace education.	• Develop educational MMOGs with peace related missions • Develop 2D and 3D simulations about the consequences of war (i.e. a simulation of the Earth as it would look without wars). • Use ICT to allow children from schools around the globe to collaborate on WebQuests, poetry, storytelling, art and photography on the topic of world peace.
Technology for conflict management.	• Develop special social networks platforms aiming to match and 'friend' people of different cultures and political stands with ultimate goal to socialize and learn from each other. • Develop technology applications (e.g. Facebook apps, mobile device apps and tabletop apps) aiming the facilitation of conflict resolution.
Technology for diminishing inequalities.	• Eliminate digital divide (i.e. helping all households gain access to the Internet) promotes peace indirectly.
Technology for organizing events.	• Organize protests and other peace related events in virtual worlds (e.g. Second Life) that will attract users but also media attention. • Organize a large mass group of people for street protests or online actions related to peace.

Table 4. Persistent ideas on using technology for the social integration of the immigrants of Cyprus.

Theme	Most persistent and discussed ideas
Technology for intercultural education.	• Online courses on learning the Greek language for adult immigrants. • Online tutorials for basic skills, such as understanding the road signs and rules. • Online seminars for immigrants to learn more about the Cypriot culture. • Educational software for school children (locals) to learn about the cultures of the immigrants of Cyprus and vice versa. • Group activities in schools settings that encourage immigrants and locals to work together. • Online support teams for immigrants.
Technology for communication.	• Forums where immigrants and locals can exchange views in a peaceful spirit and learn how their common humanity could be useful. • Social networks for young people to 'friend' and learn more about their immigrant peers.
Technology for providing services and information sharing.	• An inclusive website focused on immigrants' needs related to their stay in Cyprus, including information about services, life, transportation, visas/work permissions, questions, answers, etc.
Technology for organizing events/entertainment.	• Organize groups of immigrants to participate in Cyprus local events (e.g. a presence at the Carnival festival). • Organize game festivals where locals and immigrants share wishes and emotions on interactive displays and play console games together with an emphasis on learning more about each other's culture and language.

5. DISCUSSION AND CONCLUSION

In this study, we aimed to explore ideas in the realm of technology for peace—a domain of interest to the research community but for which research is lacking. Tabletop technology was employed considering its already researched affordances and also seeing it as 'peace-enforcing' by design. The study focused on the systematic assessment of problem-based group collaboration around the interactive tabletop and on extracting themes relevant to technology for peace demonstrated across groups. Our findings provide interesting insights and directions for future work.

First, this study contributes to the literature with regard to a systematically developed coding scheme capturing the cognitive and physical interactions (among the participants and the technology) evident during collaboration on problem-based scenarios around a tabletop. A systematic classification of discourse was undertaken in a couple of previous studies (i.e. Shaer *et al.*, 2011; Jamil *et al.*, 2011), but with a different research focus; thus, our coding scheme is unique in the context of problem-based tabletop collaboration. Our coding scheme was systematically developed and used with one dataset (global peace scenario), then applied and reused in another dataset (immigration scenario). This provides some evidence for its applicability in this context and possibly other similar settings. We suggest, this scheme can be applied and extended to more studies in the area.

Second, the coding scheme constitutes evidence that collocated, tabletop collaboration in the context of this study shares similar characteristic with small group collaboration in distributed learning settings. In particular, successful collaboration in distributed learning settings is characterized by contributions of content, cognitive/ meta-cognitive exchanges (e.g. asking question, exchanging conflicting opinions) among others. The participants of this study demonstrated analogous discourse (e.g. proposing ideas, elaborating, questions and answers). We believe our systematically developed coding scheme is a step toward bridging the gap between co-located and distributed collaborative learning research.

Third, on the basis of previous work, we deemed an interactive tabletop to be the most suited interface for the study, providing a shared workspace for co-located collaboration on peace ideas. The participants' engagement with the task and the numerous cognitive and physical, task-focused contributions provide some evidence for this assumption. Yet, it is possible that a novelty effect can explain the participants' engagement, and only a longitudinal study would be able to shed light on this finding. Also, without a control condition (i.e. experimental design), we cannot be certain about the added value of the technology. Perhaps, similar participation and collaboration could have taken place with a simple brainstorming activity, without a tabletop.

Furthermore, this work considered the technology as 'peace-enforcing' by design, allowing 'power' to be shared and distributed over a shared display, thus becoming pertinent to group work on peace-related tasks. This idea also found some premise in our data. The participants not only demonstrated turn-taking behavior during their collaboration but also participated fairly equally within their groups. An interesting future direction would be to investigate how tabletops 'share power' between real conflicting parties—such as Turkish with Greek Cypriots and immigrant with nonimmigrants—while they collaborate on a shared goal around a tabletop (e.g. Stock *et al.*, 2008). Although we have avoided this authentic (but potentially problematic) setting to date, it is definitely a case worth perusing in future works and should be of interest to the research community.

In the same spirit, future work should explore how tabletops (and associated applications) can be tailored to mediate collaboration on sensitive and controversial issues. In the present study, even though our scenarios were considered 'personally important' to the participants, there was no evidence of tension, anxiety or strong disagreement, which are often linked to discussions of sensitive and controversial issues. One could suggest that our participants did not experience the scenarios as 'sensitive' or 'controversial' even though they may have been 'personally important' to them. On the other side of the coin however, one could think that tabletops encourage playfulness in interaction (Piper and Hollan, 2009; Jamil *et al.*, 2011), which may have made the activity fun, rather than emotional, especially considering the social talk and laughter evident during the activity (see Table 1 and Fig. 5). We simply do not know; our current dataset cannot support the testing of these hypotheses. Future investigations in this direction should measure the 'sensitivity' of the scenarios for the participants and also compare to a clear not sensitive case, in order to address the technology effect in this case, if one exits. Certainly, collaboration on sensitive and controversial issues around tabletop should be an interesting area for research in the field.

Furthermore, the study may be suggesting the use of problem-based scenarios around peace and immigration as good collaborative activities that also serve an important purpose. Not only students produced and discussed numerous ideas on the topic, but also collaborated well in constructing consensus taxonomies. That is, for the duration of the activity (40–60 min), they were activity engaged in the task as evident from their discourse and interactions (e.g. see Table 1) and the numerous collaboration acts and turns. Yet again, we need experimental studies in future investigations to factor out other plausible explanations for these results (e.g. novelty effect and technology effect).

Last but not least, the study contributes a list of consolidated themes, but also individual ideas, in the realm of technology for peace. A further meta-review of the participants' contribution across both scenarios (peace and immigrations) offered three larger dimensions in this arena. These themes and dimensions enrich the results of the recent systematic review by

Veletsianos and Eliadou (2009), which only emphasized the use of technology for educational tasks (learning activities) relevant to peace. More importantly, these themes and dimensions provide insights pertinent to future research in the HCI and learning communities concerning the use of technology for peace.

Closing, although this work is by no means complete, we can summarize four tentative implications of our initial findings for future research and practice.

1. The systematically developed coding scheme of the study can be applied (and extended) to more studies in the area.
2. The consistent themes and ideas contributed across the participating groups highlight a number of areas where research could focus in terms of using technology for peace.
3. Problem-based scenarios around peace and immigration may be good collaborative activities, while serving an important purpose.
4. Multi-touch interactive tabletops and associated applications can be tailored to facilitate collaboration on a shared goal. Cases of tabletop collaboration with conflicting parties and sensitive/controversial issues are worth exploring.

Overall, this study calls for further research on peace and technology in the education and HCI arenas, while taking advantage of current technologies that are 'peace-enforcing' by design.

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