Collaborative Learning through Creative Video Composition on Distributed User Interfaces

Conference or Workshop Item

For guidance on citations see FAQs.

oro.open.ac.uk

Collaborative Learning through Creative Video Composition on Distributed User Interfaces

A.-S. Dadzie[1]⋆, M. Müller[2], A. Alissandrakis[2], and M. Milrad[2]

[1] KMi, The Open University, Milton Keynes, UK
[2] Dept. of Media Technology, Linnaeus University, Växjö, Sweden
aba-sah.dadzie@open.ac.uk,
maximilian.muller,aris.alissandrakis,marcelo.milrad{@lnu.se}

Abstract. We report two studies that fed into user-centred design for pedagogical and technological scaffolds for social, constructive learning through creative, collaborative, reflective video composition. The studies validated this learning approach, and verified the utility and usability of an initial prototype (scaffold) built to support it. However, challenges in interaction with the target technology, multi-touch tabletops, impacted ability to carry out prescribed learning activities. Our findings point to the need to investigate an alternative approach, and informed redesign of our scaffolds. We propose coupling of distributed user interfaces, using mobile devices to access large, shared displays, to augment capability to follow our constructive learning process. We discuss also the need to manage recognised challenges to collaboration with a distributed approach.

Keywords: CSCL, creative video composition, reflective knowledge construction, shared displays, distributed UIs, process support

1   Introduction

We describe research effort in an EU project that aims to explore how the process of production and reuse of digital video content can be harnessed to overcome barriers to conceptual understanding of STEM (Science, Technology, Engineering, and Mathematics) topics. The project is grounded on a specific pedagogic framework that aims to identify "*threshold concepts*" (TCs) [9] – key concepts that constitute learning barriers – and facilitate understanding through the creation and sharing of explanatory, expressive, student-managed videos. These, with additional data, such as quizzes and peer comments, and subsequent engagement with viewers via interactive public displays, constitute what we call a "*video performance*" [10].

   We explore how software designed to augment reflective, collaborative video composition on shared, multi-touch surfaces promotes co-located, collaborative knowledge construction within a prescribed learning process. By encouraging target users to *inform* the design process [12], we identified challenges in interaction

---

⋆ A.-S. Dadzie carried out most of this work while at Birmingham University.

during early evaluation of this technological and pedagogical scaffold; we explore further design to ensure fluid collaboration and, therefore, deep, reflective learning [3]. We envisage, through this process, to build more effective scaffolds for collaborative knowledge discovery and construction, review and consolidation.

We present, first, our research objectives and the methodology followed, then discuss the outcomes of our studies. We conclude with pointers to redesign of our scaffolds, taking into consideration learning and guidelines from related work.

2 Research Objectives

Our aim, illustrated in Fig. 1, is to build scaffolds that augment the construction of deep, shared, conceptual understanding. Our approach harnesses collaborative story creation, performance and video-making as a way to foster creativity and curiosity, engender alternative, visual thinking and maintain engagement as students explore pre-identified stumbling blocks to understanding of TCs in STEM. Students are guided to craft stories that *juxtapose* TCs against alternative, creative, real-world or other experiences they relate to. Doing this through performance and video-making requires students to step through a process of collaborative knowledge discovery and construction, leading to deep, correct understanding of a TC and its component parts [3,9,10,14]. Further, the resultant video serves as a tangible artefact and expression of understanding, and an avenue for further reflection on, and hence, reinforcement of any knowledge gained.

Longitudinal studies with a variety of students and teachers have provided empirical evidence, that confirms research pointing to the potential in our approach to social, constructivist learning [3,10]. We follow a user-centred design methodology, examining options for building pedagogical and technological scaffolds for students and also the teachers or orchestrators of learning activities in typical classrooms and more flexible learning environments. Building on research in Computer-Supported Collaborative Learning (CSCL), we started with a premise of technological support for co-located, collaborative learning activities around large, shared, multi-touch tables. This was to harness recognised benefits exhibited in intuitive, active, enthusiastic, tangible interaction within groups around tables [3,4,5,7,11,15]. This leads to our initial research question:

> *Is interaction around a large, shared, multi-touch table sufficient in itself as an enabler for augmented, collaborative, reflective construction of understanding?*

Existing studies ([4,5,11], among others), confirm the merits of this initial proposal to support collaborative learning around multi-touch tables. However, collaboration comes with its own challenges, including conflict due to group dynamics, ensuring equitable contribution, effectively supporting distributed tasks and transitioning back to whole group activity – challenges that may be compounded by limitations in the supporting technology [3,5,15]. These must be carefully managed, to ensure they do not outweigh the benefits of CSCL. Other

practical considerations, associated specifically with reliance on digital touchtables, include still very high financial cost, low portability due to physical size and weight, and hence, limitations in scalability of tabletop-based solutions for CSCL. Orientation of the display, combined with table size, present further challenges for interaction, which may exclude users with physical and learning disabilities.

To be successful in meeting our goal – to enable deep, conceptual understanding, we must ensure a practicable solution that fosters reflective, collaborative knowledge construction, without increasing learners' cognitive load [15]. We present, in section 3, our methodology for exploring this initial proposal.

3 Methodology

The introduction of *Information and Communication Technology* into the classroom is increasingly commonplace, especially for inquiry-based teaching and learning, as is often used in STEM [2,13]. This is due largely to wide availability and affordability of personal computers (PCs), and now, also, small, personal devices such as smartphones and tablets [1,8]. Interactive whiteboards, often with custom learning software, are gradually replacing traditional classroom blackboards [6]. Studies show that multi-touch tables, a variant of large displays, foster collaboration, supporting social, interactive learning [3,11]. Touchtables are however still regarded as relatively new, and less accessible technology [4,5,15].

While studies such as in [14] provide evidence for the merit in our constructive learning approach, driven by creative, collaborative video-making, we must still provide evidence for its utility and applicability, along with intuitive support for implementation within established/traditional learning structures and institutions, if we are to see adoption in practice [2,10]. A key component of our design is therefore to involve a good cross-section of our target users (students and teachers) as informants to the system and user interface (UI) design (see [12]), and through a process of iterative usability evaluation.

We focus on two design studies, in sections 3.1 and 3.3, with secondary school and post-graduate students, respectively. We restrict our discussion to participants' interaction with the technology for two key steps in our learning process, highlighted within the red frame in Fig. 1a: (1) the *interpretation/understanding* gained during **storyboarding**, as students craft their initial story ideas; (2) the *reflection* engendered as they **compose** a final video that expresses creatively the understanding gained through this process. All user sessions were video and audio recorded, to supplement researchers' observations captured in written notes.

3.1 Case Study I: Design sessions with secondary level pupils

We carried out initial and follow-up studies, in Jul 2013 & '14, with a key target user group: 15-16 year-olds at a stakeholder school in England (just after completion of the 'General Certificate of Secondary Education' exam), to inform the design of the initial prototype (see section 3.2). Participants followed the learning process from storyboard creation through to performance, filming and
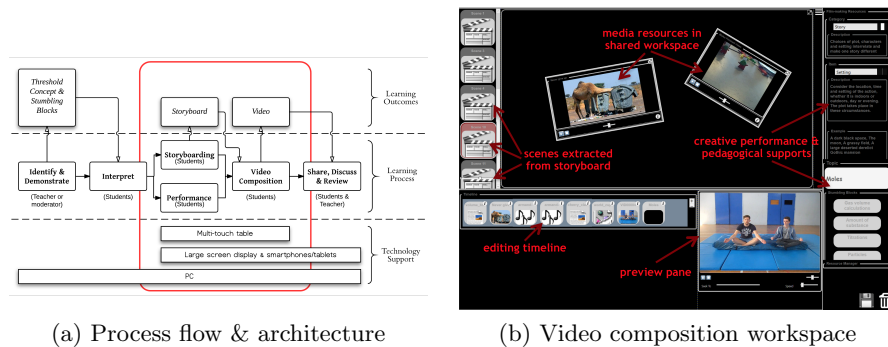
(a) Process flow & architecture   (b) Video composition workspace

Fig. 1. Technological and pedagogical scaffolds for collaborative, reflective learning. Additional, detailed snapshots of the UI may be found at: `http://bit.ly/1SUIRCc`

video composition (some sessions ended just short of producing a final video), on a teacher-selected topic. The aim was two-fold: (1) to provide initial assessment and verification of the learning process itself (Fig. 1a); (2) to trigger design ideas for the technological scaffold required for effective task completion.

Storyboarding (planning/interpretation) was carried out on paper templates (size A3) on flat, physical surfaces. In the first study, with 13 participants in two groups, one carried out the video composition activity on a multi-touch tabletop, using a medium-fidelity [4] video browsing prototype. The second used Apple's *iMovie*[3], from a Macbook Pro with its display projected onto a wall. In the follow-up study, with 17 participants in five groups, video composition was carried out on a shared desktop or laptop (screen size 15.4/17in). Four used TechSmith's *Camtasia*[4] and one, iMovie. In addition to the first two goals, this study sought concrete measures of the resources – time and technological support – required for implementation within the regular classroom schedule and environment. Using commonly available software and hardware further provided a baseline from which to measure added value in following our learning process.

3.2 Initial Touchtable-based Prototype

Guided by the outcomes of the design studies in section 3.1, a number of subsequent studies following the same methodology in a variety of formal and non-traditional learning environments, and earlier studies with teachers/instructors (see also [3,10]), we carried out further, comprehensive analysis of the CSCL literature. This extended requirements and design phase resulted in an initial prototype targeted at the multi-user, multi-touch table, implemented using the *Microsoft Surface 2.0 SDK*. This has been tested on the *Samsung SUR40* touchtable with *PixelSense*[5], and on laptops running the Surface emulator in Win 7 & 8.

---

[3] `http://www.apple.com/uk/ilife/imovie`

[4] `http://www.techsmith.com/camtasia.html`

[5] `https://msdn.microsoft.com/en-us/library/ff727815.aspx`;
  `http://www.microsoft.com/en-us/pixelsense/whatsnew.aspx`

Fig. 1a maps stages in the learning process to key components in the prototype and the supporting technology envisaged. Two main modules are available, that make use predominantly of *drag-and-drop* interaction in a highly visual interface: **storyboarding,** built to reflect a traditional storyboard template, with additional support for attaching electronic resources to scenes; **video composition** (see Fig. 1b), that may be initialised from a storyboard, to persist backward, also, subsequent modifications to the storyline. The aim is to provide both process support and enable reuse of the knowledge artefacts thus created.

Support for parallel, sub-group activity includes, e.g., extracting individual scenes and resources to transient spaces etched out of the shared workspace. Simple means for capturing notes, storyline and resource metadata, and seamless tagging of elements allows such information to be persisted through to production of the final video. We describe briefly, in section 3.3, its initial evaluation.

3.3 Case Study II: Design sessions with university students

This study, in Jan 2015, aimed to assess where the UI design and underlying system functionality for the prototype (scaffold), described in section 3.2, foster knowledge discovery and capture during video-making. The evaluation also looked particularly at the impact of the target device (the multi-touch table) on collaboration, and hence, deep, reflective learning. The participants were masters level media technology students at a Swedish University, acting as (domain) expert reviewers. In the first session seven participants were given an overview of the learning process (Fig. 1a). They then carried out a short storyboarding exercise on the tabletop, guided by a topic about which a subset had some knowledge. Using the custom conversion facility, the storyboard was used to populate the initial view of the video editing timeline. The participants carried out an inspection of the video composition workspace, to identify additional requirements and functionality, beyond the technical requirements for producing a video, to support continued (collaborative) reflection and knowledge construction.

A follow-up session with five participants (four from the first), reviewed an update to the UI (in Fig. 1b), based on feedback to this point. This focused on the video composition activity and the following step in the learning process: sharing of student videos and soliciting feedback via public, large screen displays coupled with smaller, mobile devices (smartphones and tablets). The study concluded with a brainstorming session in which the participants, based on their domain expertise, gave an assessment of where they saw added value as a pedagogical scaffold, over traditional video editing tools. To address interaction issues on the tabletop, we asked them to consider requirements for alternative technological support, including reuse of the (distributed) set-up for the sharing phase. We discuss our findings and the implications for further work in sections 4 and 6.

4 Discussion

A key aspect of our learning approach is to harness collaborative knowledge construction as a trigger for peer and reflective learning. Evaluation with stu-

dents, with a good degree of variation in level of study, learning environment and group dynamics, has validated this creative learning process (see also [10,14]), confirming also existing research in social, constructive learning, especially where supported by dedicated technological scaffolds [1,6,7,8,13].

To ensure these benefits translate in practice, we revisit key observations across the two studies reported in this paper, supported also by other relevant project studies. To answer our research question (in section 2) – to what extent interaction with the pedagogical and technological scaffolds on a shared, multi-touch table meets the requirements of student groups following our process – we examine also practical requirements for implementation in the classroom. We address elements that participants recognised to (1) foster effective collaboration, thereby augmenting capability for (2) achieving learning goals, and (3) for carrying out the technical tasks involved in this process, for crafting, then translating their story ideas into an expressive video, and (4) finally, sharing the outcomes with their peers. We also highlight where use of these scaffolds was hampered.

4.1 Key Findings

Fostering Collaboration Storyboarding stands out, across all user studies, as the activity in which a high degree of collaboration was initiated and maintained, as students worked together to break down the learning topic and collect and **reflect** on the knowledge and resources that would contribute to their stories. With respect to interaction, the practicalities of editing a paper storyboard led each group to appoint a *scribe* at the start, while the others mainly contributed to the discussion. On the tabletop, however, the initial response was for most of the group to attempt to interact with the UI at the same time. However, even with the larger workspace, and also because of delayed responsiveness of the hardware, participants found that they got in each other's way (see also [5,11,15]). The group concluded that they would have to take turns or appoint a "secretary" if they were to make optimal use of the (digital) workspace.

Meeting Learning Goals The video produced serves as a tangible outcome of the collaborative learning activity. However, as reiterated in [3,10], the **process** involved in reaching this goal is where true learning is obtained. We have evaluated support for the video composition activity from three perspectives: (1) using traditional video editing tools: (a) from a large, shared display obtained by projecting from a laptop onto a wall; (b) around (single-user) PCs or laptops; (2) using the prototypes developed for the multi-touch table. From a pedagogical standpoint, option (1b) can be discounted; confronted with a technical tool on single-user machines, the activity was treated as a technical task, in which mainly group members with prior technical know-how participated. Collaboration almost completely broke down, and with it, the valuable reflection on and reinforcement of new knowledge gained and the identification and correction of misconceptions, that was seen in the other two settings (a similar outcome is reported in [11]). Increasing the physical workspace in option (1a), by projecting onto a wall, increased usability as a shared resource. Here, even still working

with a technical video editing tool, active discussion and joint reflection on the knowledge content drove the activity. Finally, in addition to custom support for accessing topic-specific learning material in option (2), a key benefit seen was explicit support for persisting information collected at each stage throughout the process. The table comfortably accommodated seven adults (upper limit tested, average was three to four). As in (1a), the large, shared view engendered active discussion. However, this was handicapped by inability to take full advantage of the simultaneous, multi-user interaction that was a driver in proposing the multi-touch table as the target device.

Sharing & Soliciting Feedback Technological support for the ***sharing*** stage in the learning process builds on studies in [10]. These solicited requirements for encouraging serendipitous collaboration between peers and students who would not normally interact with each other, by situating large displays playing the student videos in public spaces. The aim was to draw passing students to engage with the educational content using a public controller for the video stream, or extend the shared space to their personal smartphones or tablets, to allow further interaction, e.g., posting and receiving personalised feedback. Following on the advantages seen in persisting knowledge content across the video-making activities, participants recognised value in sharing also, beyond these public spaces, the interim artefacts (e.g., storyboards, video clips) as reusable learning resources.

4.2 Design Implications

These outcomes revalidate our learning process, but reinforce the need for custom scaffolds to harness its full potential. They also highlight challenges for adoption, and therefore the need to revisit the proposed technological scaffold. Considering the challenges experienced in multi-user interaction with the touchtable, the cost of acquisition and installation becomes even more significant. On the other hand, participants saw potential in extending the distributed set-up for sharing videos in public spaces as a means to optimise especially the video composition activity, which has greater distribution of sub-tasks. Based on our observations of student interaction in the different settings, and design ideas triggered by the discussions:

> *Would a distributed approach, utilising smaller, more accessible, portable, touch devices, coupled with a large, shared display, maintain collaboration, and therefore, augment reflective construction of understanding?*

To answer this (revised) question, we reviewed responses to the questions that guided the semi-structured debrief and brainstorming sessions that concluded each design study. Because this work is exploratory, we focus on the rich, qualitative information collected, complemented by records of each session. Guided by this, we carry out further investigation of relevant work (in section 5), before concluding with pointers to redesign. We aim to keep cost – financial, development effort and path to adoption – low by reusing easily accessible technology. However, we must still develop novel, alternative approaches that engender and maintain collaboration while using a coupled, albeit distributed set-up.

5 Related Work

To increase confidence in adoption of our approach, especially in formal learning environments, we must provide both a theoretical foundation that validates it, and practical, customisable, pedagogical and technological scaffolds that allow teachers to integrate these into the classroom. Therefore, we look at examples of the use of large, shared displays to foster collaboration. Dillenbourg *et al.,* [5] discuss the merits of co-located collaboration around tabletops, but also caution over expectation of what is still relatively new technology. They propose a number of recommendations for optimising the use of touchtables in collaborative learning. Yuill *et al.,* [15], similarly, caution the notion that interaction around shared tabletops automatically leads to natural or seamless collaboration.

It is imperative that we do not simply replace the interaction issues faced on multi-touch tables with a different set of challenges. Rogers *et al.,* [11] compare interaction on horizontal and vertical displays in an information seeking task: in isolation horizontal displays led to more exploration, due to more natural turn-taking and diversity in information examined. However, working with them was seen to be less structured than with vertical displays. Importantly, complex activity requiring interaction with a shared display and other information artefacts (e.g., paper) was most effective when physical layout and constraints simplified transition between devices and increased awareness of other parallel activity. This gels with [2], where replacing a fixed PC with a tablet increased an instructor's flexibility, moving about a classroom, to assist problem-solving activities.

Other studies employ more widely available technology, such as interactive whiteboards and large monitors attached to PCs, to increase space for collaborative problem-solving [6]. Liu *et al.,* [8] investigate the role of a large screen display in augmenting functionality in mobile devices; the shared workspace facilitated communication during collaborative learning, leading to significantly more interaction and discussion among students. Lamberty *et al.,* [7] report a study in which classmates shared visual mathematical artefacts describing new concepts, by projecting from their PCs onto a large screen. As in [2,3,15], knowing their solutions were intended for a wider audience, learners were more conscious of content and presentation. This also piqued interest in other groups' work, providing additional benefit from the exercise. This mirrors comments in a number of our studies as participants built and reflected on their stories to ensure they would appeal to and engage their peers, in addition to teaching about the TC.

Our studies have given us insight into the affordances of various settings for technological support. Comparing with the baseline – traditional video editing software on single-user PCs – reinforced the potential in our creative learning process. However, this potential will only be realised if it is accompanied by practical scaffolds that enable effective adoption and truly augment learning. The studies we report enabled us to collect valuable design ideas for these scaffolds, and recognise also limitations in our initial proposal, based on interaction around multi-user, multi-touch tables. Continued research points to a novel approach to this challenge: employing a more distributed environment, but centred around a large, shared, digital workspace, to which smaller, personal and shared touch

devices are coupled, to continue to foster the tangible collaboration that is key to our constructive learning approach. We conclude with our revised proposal.

6 Conclusions & Future Work

The ideal scenario would employ a setup that allows the collaboration fostered at the start of the creative video-making process to be extended through to the final sharing phase. Empirical evidence and research demonstrate correlation between fluid, equitable, collaborative knowledge discovery and problem-solving [6,14,15], and joint reflection on the knowledge thus discovered [3]; a process that results in turn in consolidation of, and therefore, deep conceptual understanding. While a more distributed approach addresses requirements for portability and affordability, and is particularly useful for synchronous, sub-group tasks [7], working on devices designed for individual use comes with the danger of lowered awareness of other parallel activity [11] and disengagement from the shared task. Our revised design comprises a large screen for sharing and maintaining awareness of peer (group) work, synced with PCs, smartphones and tablets serving as input devices, and for parallel, sub-group tasks during the creative video-making (storyboarding and video composition). Existing work shows that in such distributed environments, being able to recognise, even in the periphery, other contributors' work, helps to maintain awareness of the shared task and results in an increase in interaction [7,8]. Our proposal therefore includes support for communication between all devices via the shared, central device, to facilitate collaboration. Participants also suggested avatars on the shared screen, to simplify recognition of and access to others' work, analogous to peering over their shoulders.

It is imperative in such scenarios that effective means are provided for transitioning back to the overall shared task [5,15]. Each synced device will also act as a controller, to allow sub-group work to be mirrored to the shared screen. A central, "super" controller was also proposed; this should be particularly useful for teachers/orchestrators, to maintain an overview of students' classroom activity. Participants saw additional benefits in this, for monitoring sub-group work in order to minimise distraction, to draw attention to a specific solution [2], or, importantly, to recognise where a group requires extra support.

The next stage in our work is to investigate, further, options for achieving this in both software and hardware, to translate the updated requirements and redesign into a more usable, more effective version of the working prototype. We envisage this set-up will ensure, also, seamless transition from the video-making activity to the sharing phase, removing the current separation of these steps in the learning process. We will investigate, further, how to enact different learning tasks that support tighter integration between the activities around the shared workspace displays and more traditional classroom activity. This is to ensure that the interplay of the multiple, coupled devices still maintains collaboration during the closely shared task of storyboarding and the more distributed activity in video composition and review; so that the new scaffolds truly augment reflective learning, and lead to deep, conceptual understanding of TCs.

References

1. Alvarez, C., Alarcon, R., Nussbaum, M.: Implementing collaborative learning activities in the classroom supported by one-to-one mobile computing: A design-based process. Journal of Systems and Software 84(11), 1961–1976 (2011)
2. Alvarez, C., Milrad, M., Borie, F., Luna, M.: Collphoto: A paper + smartphone problem solving environment for science and engineering lectures. In: Collaboration Technologies and Social Computing, pp. 1–15 (2014)
3. Dadzie, A.S., Benton, L., Vasalou, A., Beale, R.: Situated design for creative, reflective, collaborative, technology-mediated learning. In: Designing Interactive Systems Conference (DIS '14). pp. 83–92 (2014)
4. Derboven, J., De Roeck, D., Verstraete, M., Geerts, D., Schneider-Barnes, J., Luyten, K.: Comparing user interaction with low and high fidelity prototypes of tabletop surfaces. In: 6th Nordic conference on Human-computer interaction (NordiCHI '10) (2010)
5. Dillenbourg, P., Evans, M.: Interactive tabletops in education. International Journal of Computer-Supported Collaborative Learning 6(4), 491–514 (2011)
6. Dillenbourg, P., Traum, D.: Does a shared screen make a shared solution? In: 1999 Conference on Computer Support for Collaborative Learning (CSCL '99) (1999)
7. Lamberty, K.K., Froiland, K., Biatek, J., Adams, S.: Encouraging awareness of peers' learning activities using large displays in the periphery. In: CHI EA '10 extended abstracts, 28th international conference on Human Factors in Computing Systems. pp. 3655–3660 (2010)
8. Liu, C.C., Chung, C.W., Chen, N.S., Liu, B.J.: Analysis of peer interaction in learning activities with personal handhelds and shared displays. Educational Technology & Society 12(3), 127–142 (2009)
9. Meyer, J.H., Land, R.: Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practising within the disciplines. In: Improving Student Learning: Theory and Practice – Ten Years On. pp. 412–424 (2003)
10. Otero, N., Alissandrakis, A., Müller, M., Milrad, M., Lencastre, J.A., Casal, J., José, R.: Promoting secondary school learners' curiosity towards science through digital public displays. In: International Conference on Making Sense of Converging Media (AcademicMindTrek '13). pp. 204:204–204:210 (2013)
11. Rogers, Y., Lindley, S.: Collaborating around vertical and horizontal large interactive displays: which way is best? Interacting with Computers 16(6), 1133–1152 (2004)
12. Scaife, M., Rogers, Y., Aldrich, F., Davies, M.: Designing for or designing with? informant design for interactive learning environments. In: ACM SIGCHI Conference on Human Factors in Computing Systems (CHI '97). pp. 343–350 (1997)
13. Selwyn, N.: Education and technology: key issues and debates, chap. Does technology improve learning? Bloomsbury Academic (2011)
14. Sousa, D.A., Pilecki, T.: Why STEM should become STEAM. In: From STEM to STEAM: Using Brain-Compatible Strategies to Integrate the Arts, pp. 9–35 (2013)
15. Yuill, N., Rogers, Y.: Mechanisms for collaboration: A design and evaluation framework for multi-user interfaces. ACM Transactions on Computer-Human Interaction (TOCHI) (2012)