Unearthing Invisible Buildings:  
Device Focus and Device Sharing in a Collaborative Mobile Learning Activity  

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ABSTRACT  
Recent research has identified excessive device focus as a serious problem in collaborative mobile learning as it undermines key ideas of learners engaging with their co-learners in context-rich authentic settings. Various recommendations have been formulated to address device focus in the design of mobile learning technology and pedagogy and foster students’ engagement with both their peers and their environment. This paper describes how some of these recommendations have been implemented and extended in the design of Invisible Buildings, a mobile collaborative game-based activity for schoolchildren. It reports the results of an empirical evaluation of the learning experience with primary school children, focusing on students’ engagement with their social and physical context during learning activities, and providing insights into their behaviour and strategies with respect to device sharing. Findings broadly confirm the effectiveness of the implemented measures and show good student acceptance of the tools employed and the overall learning experience.  

Keywords:  Collaboration, Context, Device Focus, Device Sharing, Mobile Learning  

INTRODUCTION  
Over the last decade our understanding of mobile learning has shifted focus from mobile devices and technologies to learner mobility and the social practice it enables. A key concept in this new understanding is context, created by the learner in interaction with others, with their surroundings and with the tools they use (Kukulska-Hume et al., 2009). As learning processes are inextricably linked to, and located within, a particular context, learning in context-rich authentic settings can make the learning experience more relevant and meaningful for students and help to bridge the gap between theory and practice (Rogoff, 1982; Lave, 1988; Brown et al., 1989; Engeström, 1991). In addition, the construction of new knowledge from concrete and detailed experience can help learners to gain a deep and multifaceted understanding, which in turn enables them to more easily transfer skills and knowledge to other problem domains (Spiro et al., 1988). Collaborative situated learning activities put additional emphasis on the social aspects of learning and require students to test ideas, processes and concepts with their peers, negotiate meaning, and in the process construct new knowledge relevant to
their common task. Rooted in Vygotsky’s (1978) and Bandura’s (1977) ideas of learning through observation, communication and social interaction, the benefits of collaborative learning are now widely accepted.

Key to leveraging these manifold theoretical advantages of collaborative mobile learning is that students register, engage and interact with their environment and with their co-learners during the learning activity. Recent research, however, has pointed out that in many mobile learning projects where students share a mobile device to complete tasks collaboratively their engagement with the environment and with each other is reduced significantly as they focus too much on the shared mobile device (Eliasson et al., 2010, 2011; Göth et al., 2006).

From an HCI perspective, where device focus and its underlying issues have been researched for some time (e.g., Satyanarayanan, 1996; Kristoffersen & Ljungberg, 1999), efforts to address the problem are generally aimed at reducing the cognitive load for users when interacting with the device. Earlier approaches in this context include Minimal Attention User Interfaces (Pascoe et al., 2000), which groups interaction tasks into interaction modes to reduce interface complexity, and sonically-enhanced user interfaces that balance visual interaction with acoustic feedback to reduce cognitive load (Brewster, 2002). More recent efforts include user interfaces that account for contextual information, such as enlarging touch targets when a user is walking (Kane et al., 2008), gestural input (Crossan et al., 2008, 2009) and Around-Device Interaction (Kratz & Rohs, 2009) for simple actions that don’t require fine-grained interaction, and tactile feedback for situations where interaction with graphical displays is not suitable (Hoggan et al., 2007).

Göth et al. (2006) proposed the development of a mobile phone metaphor (as opposed to a small screen metaphor derived from the desktop) for the design of situated mobile learning applications, which takes into account the specific use context, hardware characteristics and network requirements of mobile devices. Unlike desktop applications which claim the exclusive and un-interrupted focus of the user, the mobile phone metaphor accounts for discontinuous use by requesting the user’s attention when necessary and then switching into the background automatically when the user’s focus is no longer required. A detailed discussion of task switching in mobile situations and its demand on cognitive resources is offered in Oulasvirta et al. (2005).

From a pedagogical perspective, Eliasson et al. (2010) recently proposed addressing the problem of excessive device focus with a range of measures, including assigning learners dedicated roles that require negotiation and coordination in collaborative learning situations, conceptualising mobile devices as tools that support learners in completing activities (as opposed to controlling and structuring the activity) and integrating teachers and support staff into mobile activities to scaffold learning and keep learners focused on the task.

This paper describes how device focus and the related issue of device sharing among students were addressed in the design of Invisible Buildings, a mobile collaborative game-based activity for schoolchildren. It explains how some of the recommendations in Eliasson et al. (2010) were implemented and further extended in the project, and reports on the empirical evaluation of these measures with respect to device focus and device sharing in groups as well as usability, acceptance and overall user experience.

The following sections first give an overview of the Invisible Buildings project and then describe specific design aspects in the learning experience aiming to address the problems of device focus and device sharing. We explain how the learning experience was empirically evaluated with two classes of school children and conclude with a discussion of our findings and their validity.

1. INVISIBLE BUILDINGS

Invisible Buildings is a whole-day, cross-curricular learning experience for primary school children aged 9-10 years. It is based on the
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