Towards a mixed-reality tool for collaborative mind-maps

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ABSTRACT

Traditional user interfaces such as WIMP (Windows Icon Menu Pointer) are widespread in schools. They have been proven to be useful in many scenarios, yet they are unfit in the case of collaborative learning. This work aims to understand, design and prototype reality-based interactions to enable collaborative learning. To do so, we first have to understand the key components, and particularly, the cognitive processes underlying such interfaces and how users and artefacts interact with each other. Then, we will implement a tangible and augmented interface supporting learning in school context based on conceptual frameworks and literature. This talk will present our ongoing work on this direction.

Author Keywords

Spatial Augmented Reality; Tangible Interaction; Collaborative Learning; Distributed Cognition.

ACM Classification Keywords

H.5.1 Multimedia Information Systems: Artificial, augmented, and virtual realities; H.5.2 User Interfaces: Prototyping.

INTRODUCTION

The wide majority of digital applications are mainly based on WIMP interfaces, controlled by way of mice and keyboards. Such interfaces have shown some great benefits in fields like web browsing, text editing, and so on. On the other hand, they are limited as soon as collaborative interaction or hands-on activities are required [10]. This is particularly true for learning applications [15].

Beyond WIMP interfaces, reality-based interaction (RbI) "*increases the realism of interface objects and allow users to interact even more directly with them using actions that correspond to daily practices within the non-digital world.*" [8]. It also provides hands-on activity and gestures which enhance the user's learning abilities [6]. Good examples of RbI are Tangible User Interfaces (TUI, physical handles manipulating virtual information) [13] and spatial augmented reality (SAR, complementing the real world with digital content) [11]. Both SAR and TUI are known to support collaborative activities like learning and problem solving [4].

Our goal is to go towards learning interfaces that support collaborative learning. In this work, we are interested in exploring new forms of interactions such as reality-based interaction. To this end we will need first to understand, from a cognitive science point of view, what are the determinants enabling interfaces to propose effective collaborative learning activities. Then, we will design interactions with the guidelines from previous work and frameworks in cognitive science. Finally, we will implement our interactions and propose new reality-based interfaces.

To foster collaborative learning, we chose to implement the mind-map technique [1], which allows users spatializing, categorising and sorting items, to create a visually organised graph of information. Mind-maps have a variety of usages, such as studying, planning, critical thinking and problem solving [2].

This work is part of a broader project called e-Tac funded by the French education and research ministry. E-tac aims at exploring how tangible and augmented interactions can benefit to collaborative learning in school contexts from elementary school to middle-school.

UNDERSTANDING

So far, the literature has not fully identified the cognitive processes underlying tangible and augmented interactions [13], such as learning (alone or in collaboration). Some studies [12, 14] stress the importance of multi-sensory perception and movements to enhance performances with RbI. To be able to design interactions that support learning, we first have to understand which cognitive processes are involved when manipulating reality-based interfaces.

This research project aims to contribute to a better understanding of cognition in the field of HCI. Cognitive science could shed light on HCI researchers to explore which cognitive processes are solicited using tangible and augmented interfaces in a learning task while manipulating new contexts. To this end, we will explore frameworks like representation and division of space around a subject (i.e. peri-personal and extra-personal space) [3] and how these different spaces are used to specialise information on a tabletop during a learning task. Moreover, collaborative interactions will be used on our interface and we also have to consider this while designing the system. Cognitive science provides frameworks to study these types of complex relations like the distributed cognition framework [7]," which *considers a collaborative activity as taking place across individuals, artifacts and internal or external representations, as one cognitive system*" [16].

DESIGNING

Using cognitive frameworks allows us to design a set of interactions built to fit together both at individual and collective scale. By using tabletop interactions we can create a common space for users and the interface. This horizontal surface will allow us to design interaction with traditional tools like pen and paper. Hands-on activities above the surface can also be supported. Such as Papart [9] and TinkerLamp, our system [5] provide projections into the surface, supporting our system manipulation of digital objects and media.

PROTOTYPING

Once we will better understand the process involved, then we will be able to iteratively design and prototype relevant interactions. For this, the hardware components of our interactive system should enable object tracking as well as fiducial markers on a tabletop to support spacialisation of information. To do so, we will use a video-projector to display content above a surface and optical based tracking systems to track objects.

This talk will present our ongoing work towards the understanding of the cognitive science frameworks related to our project on collaborative learning with RbI, such as distributed cognition, embodied cognition and spatial representation. This talk will also allow us to present our interface currently being developed as well as the results of the pilot study on the interface's learning capacities which will be conducted before this talk.

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