Gestures on a tangible tabletop during collaborative problem solving tasks

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1 Introduction

The connection between gesture studies and TUI-based collaboration and problem solving tasks is tight, as gesturing is a communication means, and communication plays a crucial role in collaborative problem solving. In our research we explore the use of gestures in interaction with TUIs in the context of technology-based assessment of collaborative and complex problem solving skills. TUIs seem to provide a technical mean to assess the 21st Century skills (e.g., creativity, critical thinking, decision-making) and higher-order thinking skills (Schraw & Robinson, 2011). In this paper we present related work on gestures used on TUIs and the relation between gesture and cognition as well as our research goals.

2 Gestures, TUIs and Cognition

The philological foundations about gestures were established by McNeill (1992) and gestures were classified into *gesticulation*, *pantomime*, *emblem*, and *sign language*. *Gesticulation* is further classified into *iconic*, *metaphoric*, *rhythmic*, *cohesive*, and *deictic* gestures. The most prevalent type of gesture in relation to TUIs, is *pointing* or *deictic*. Goodwin (1994) considers pointing as part of events provided by other meaning-making resources, such as speech, spatial properties, body posture, and collaborative action. Murphy (2003) defined *tracing* gestures when individuals highlight the outline of a particular feature in the environment by pointing a finger at it and dragging it along or near the feature's surface. Lao et al. (2009) defined "tapping", "pressing", and "dragging" gestures and showed that a variety of hand gestures can be constructed through these three basic movements.

As far as the relation between gesture and cognition is concerned, Alibali et al. (2000) stated that gesturing reduces the cognitive load for both adults and children, particularly during

explanation tasks. Klemmer et al. (2006) pointed out that systems that constrain gestural abilities (e.g. having the hands stuck on a keyboard) are likely to hinder the user's thinking and communication. Similarly, Shaer & Hornecker (2000) stated that "by providing users with multiple access points to the system and maintaining their physical mobility, TUIs enable users to take advantage of thinking and communicating through unconstrained gestures".

3 Research Goal

The main objective of our research is to explore through user studies the gestural performance of users while interacting on a TUI in a collaborative problem solving task. The task of the participants will be similar to tasks given in the international large-scale educational Programme for International Student Assessment (PISA) programme. Through the empirical user studies, we will assess collaborative complex problem solving and reasoning skills. These studies will provide as a result a multimodal corpus of speech and gesture that will be accordingly annotated. Based on this annotation, a gesture taxonomy will be defined; in addition, this taxonomy will include *locale*-specific gestures; locale is a combination of language and culture. Last but not least, the outcomes of the study will provide input on which Interaction Design aspects of TUIs are effective for measuring collaborative problem solving and contribute to the development of assessment models and methods. With our research we would like to prove that the multimodal TUI is a cognitive artifact which enhances the cognitive capabilities of participants in achieving the necessary task, because users, maintaining their physical mobility, think and communicate by using gestures while interacting with the system (Shaer & Hornecker, 2010).

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