Abstract

This research study concerns patterns of bilingual high-school bilingual learners’ communication when they interact with a touchscreen-based dynamic geometry environment (DGE) during calculus discussion and exploration. Specifically, three research questions were proposed for the study, addressing respectively: (1) the interplay between linguistic and non-linguistic communication, (2) the mathematical competence demonstrated in the students’ activity and (3) the role of the technology for facilitating calculus thinking. Using a participationist lens and the theoretical framing of thinking-as-communicating, I provide qualitative video analyses of six pairs of participants’ communication by focusing on their word use, gestures and touchscreen-dragging actions with DGEs during their mathematical activity. The goal of this study is to identify bilingual learners’ competence during pair-work on mathematical tasks with touchscreen-based DGEs.

In Part I of the study, I compared two pairs of participants’ thinking in response to two types of visual mediators: “static” (as those found in textbook diagrams) and “dynamic” (as exploited by the use of DGEs). The analysis provides evidence that the participants utilised different modes—utterances, gestures and touchscreen-dragging—of communication. In particular, touchscreen-dragging emerged as a form of gesture for communicating dynamic and temporal calculus relationships. In addition, the students communicated the fundamental calculus ideas differently when prompted by different types of visual mediators.

In Part II, I provide analyses of communication involving four pairs of participants while exploring the area-accumulating functions with a touchscreen-based DGE. Findings resonate with Part I: the students relied on gestures and touchscreen-dragging as non-linguistic features of the mathematical discourse in order to communicate dynamic aspects of calculus. Moreover, by adopting a non-deficit model and examining the interplay among word use, gesture and touchscreen-dragging with DGEs, it was possible to identify bilingual learners’ competence in mathematical communication.

This study underscores the importance of considering bilingual learners’ non-linguistic forms of communication for understanding their mathematical thinking. It also presents
implications for teaching dynamic aspects of functions and calculus, by arguing for a multimodal view of communication to capture the use of gestures and touchscreen-dragging in mathematical communication. Furthermore, it allowed me to identify new forms of communication mobilised in dynamic, touchscreen environments.

**Keywords:** Thinking-as-communicating; bilingual learners; non-deficit model; high school calculus; dynamic geometry environments; touchscreen-dragging